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TABLE OF CONTENTS

No. 1. JANUARY-FEBRUARY

	PAGE
A Study of the Genus <i>Podaxis</i> , ELIZABETH EATON MORSE.....	1
<i>Septonema Toruloideum</i> a Stage of Mytilidion <i>Scolecosporum</i> , MARION LOHMAN	34
Further Studies in <i>Neurospora Sitophila</i> , ALICE ARONESCU.....	43
Photographs and Descriptions of Cup-fungi—XVIII. Rare Species of <i>Godronia</i> , FRED J. SEAVER.....	55
Distribution of West Indian Rusts, H. W. THURSTON, JR., and F. D. KERN	58
Notes and Brief Articles.....	65

No. 2. MARCH-APRIL

Roland Thaxter, Wm. H. WESTON, JR.....	69
The Perithecium and Ascus of <i>Penicillium</i> , B. O. DODGE.....	90
<i>Tremella Gangliiformis</i> , a New and Unique Tremellaceous Fungus, DAVID H. LINDER.....	105
Observations on <i>Epidermophyton Rubrum</i> or <i>Trichophyton Purpureum</i> , E. MUSKATBLIT.....	109
Variation in Single Spore Cultures of <i>Aspergillus Fischeri</i> , H. C. GREENE	117
<i>Dermea</i> and <i>Pezicula</i> , FRED J. SEAVER and JOSEFA VELAZQUEZ.....	139
Notes and Brief Articles.....	150

No. 3. MAY-JUNE

Photographs and Descriptions of Cup-fungi—XIX. The Cabbage-head Fungus, FRED J. SEAVER.....	157
A Taxonomic Study of the Genus <i>Hypholoma</i> in North America, CHAS. S. PARKER.....	160
Additional Studies of Species of <i>Elsinoe</i> and <i>Sphaceloma</i> , ANNA E. JENKINS	213
Notes on Boletes. II, WALTER H. SNELL.....	221
Notes and Brief Articles.....	233

No. 4. JULY-AUGUST

Notes on the Parasitic Fungi of Illinois, LEO R. TEHON.....	237
A New Fungus Parasitic on Nematodes, C. D. SHERBAKOFF.....	258
Observations on <i>Lagena Radicicola</i> , J. H. L. TRUSCOTT.....	263
Species of <i>Sclerotinia</i> from Grand Mesa National Forest, Colorado, ROSS W. DAVIDSON and EDITH K. CASH.....	266
Life Histories of <i>Trybliella</i> Species, C. L. SHEAR.....	274
The Genera of <i>Hydnaceae</i> , L. W. MILLER.....	286
New Genera and Species of Lichens from the Herbarium of Bruce Fink I, JOYCE HEDRICK.....	303

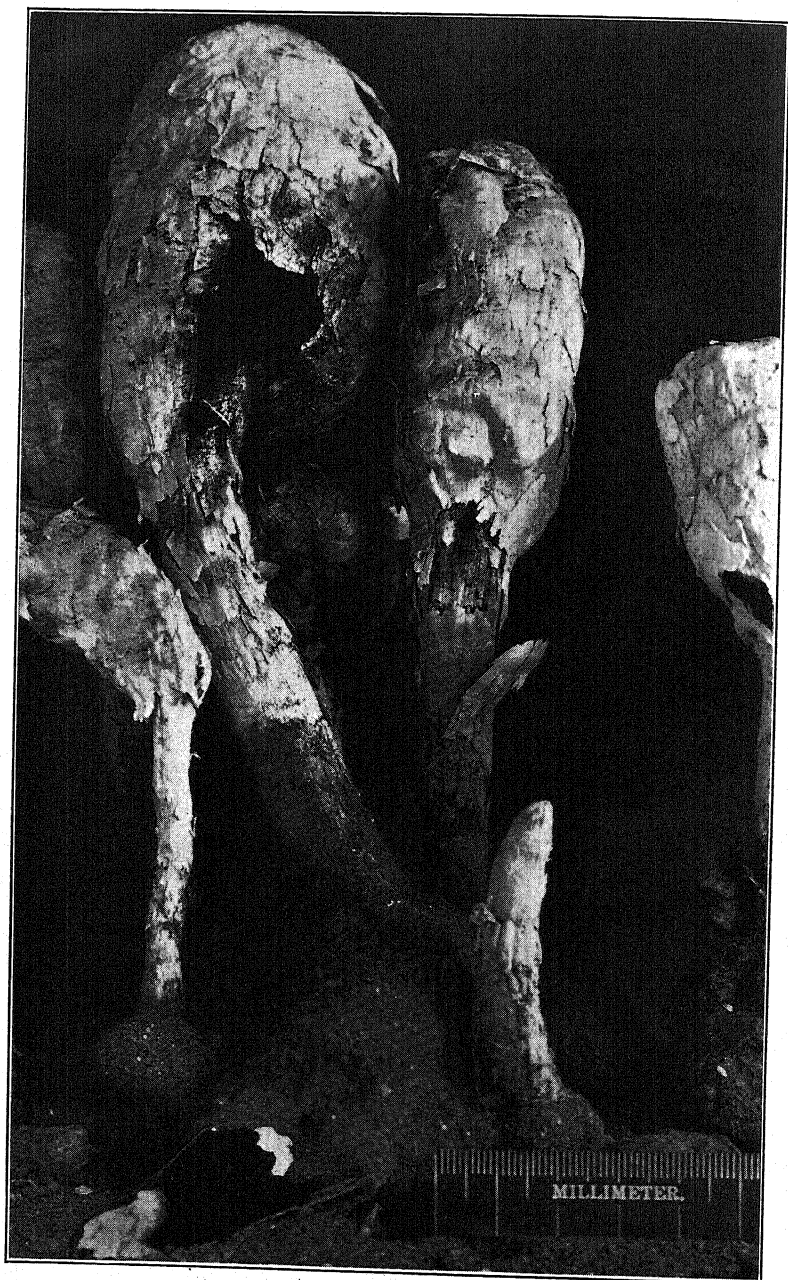
Dr. Thaxter's Metal Guard for Microscope Slides, WILLIAM H. WESTON, JR.....	317
Some New Species of Hypoxylon, J. H. MILLER.....	321
Notes and Brief Articles.....	330

No. 5. SEPTEMBER-OCTOBER

Growth of <i>Dispira Cornuta</i> in Artificial Culture, THEODORE T. AYERS..	333
North American Hyphomycetes. I. Two New Helicosporeae and the New Genera <i>Haplochalara</i> and <i>Paspalomycetes</i> , DAVID H. LINDER...	342
New and Rare North and South American Ustilaginales, GEORGE L. ZUNDEL	349
The Hydnaceae of Iowa. I. The Genera <i>Grandinia</i> and <i>Oxydontia</i> , L. W. MILLER.....	356
An Undescribed <i>Phomopsis</i> from Douglas Fir on the Pacific Coast, GLENN GARDNER HAHN.....	369
New or Noteworthy Agarics from Oregon, S. M. ZELLER.....	376
Notes on Some Species of <i>Coleosporium</i> —III, GEORGE G. HEDGCOCK and N. REX HUNT.....	392
Rusts of the Northwest Himalayas, J. C. ARTHUR and GEORGE B. CUMMINS	397
Studies Concerning Heteroecious Rusts, E. B. MAINS.....	407
Mycological Notes for 1930-32, L. O. OVERHOLTS.....	418
Abnormal Spores of Some <i>Ganoderma</i> , S. R. BOSE.....	431

No. 6. NOVEMBER-DECEMBER

The Microcyclic Species of <i>Puccinia</i> on <i>Solanum</i> , FRANK D. KERN....	435
The Standing of Two Species of <i>Uromyces</i> on <i>Panicum</i> , H. W. THURSTON, JR.....	442
<i>Plasmopara Halstedii</i> on <i>Cineraria</i> , D. L. GILL.....	446
Annotated Index of the Rusts of Colombia, F. D. KERN, H. W. THURSTON, JR., and H. H. WHETZEL.....	448
Life History and Synonymy of <i>Physalospora Glandicola</i> , NEIL E. STEVENS	504
A New Hollyhock Rust, J. J. TAUBENHAUS and WALTER N. EZEKIEL..	509
Inoperculate Chytridiaceous Organisms Collected in the Vicinity of Ithaca, N. Y., with Notes on Other Aquatic Fungi, F. K. SPARROW, JR.	513
Two Apple Black Rot Fungi in the United States, NEIL E. STEVENS....	536
Notes and Brief Articles.....	549
Index to Volume XXV.....	553



PODAXIS

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No. 1

A STUDY OF THE GENUS *PODAXIS*¹

ELIZABETH EATON MORSE

(WITH PLATES 1-12)

	PAGE
1. Introduction	1
2. Description of the North American plant: habitat, range, manner of growth, macroscopic and microscopic characters	2
3. Capillitial thread in New and Old World material	9
4. Citation of North American material examined	11
5. Citation of foreign material examined	12
6. History, tabulations, and reductions	13
7. <i>Podaxis</i> or <i>Podaxon</i> ?	24
8. Affinities	24
9. Taxonomic position of <i>Podaxis</i>	25
10. Summary	27
11. Acknowledgments	28
12. Bibliography	28
13. Explanation of plates	31

INTRODUCTION

Podaxis Desv. is a generic name now applied to a peculiar fungus which occurs generally though intermittently in somewhat restricted areas in a belt encircling the earth approximately within the fortieth parallels north and south of the equator. While mature *Podaxis* has been known to botanists for over two hundred and fifty years, its life history has never been fully made out, for several reasons; among these may be named its more or less hypogeous habit and the consequent difficulty of securing young sporo-

¹ Based on an examination of North American collections, mainly Californian.

phores. In North America there have been until recently only isolated collections and brief descriptions.

This work was started in the spring of 1929, when the writer undertook to find the fungus growing on the Colorado Desert. Many localities were visited and many inquiries made, all of which met the discouraging response, "We have never seen your plant!" Within two weeks after returning to the laboratory a packet containing three small specimens of *Podaxis* arrived from Indio, California (Smiley), with the question, "Is this the plant for which you were looking in our garden?"

Many collections came in from different places in the Colorado Desert during the three succeeding years, so that it was possible to examine several hundred specimens in a fresh state at all stages of growth.² This examination revealed the extraordinary variations which characterize the North American plant.

This fungus is described under such a diversity of generic and specific names, the descriptions indicating no greater variations than already had been observed in the Colorado Desert plant, that a query naturally arose as to the actual number of valid species.

The next quest was to assemble as much material as possible from various localities. Due to the generous response of officials connected with herbaria at home and abroad, also of foreign collectors, the writer was able to make some of the desired comparisons. Twelve distinct collections and reports were received from South Africa alone. There are many regions from which *Podaxis* has been reported that are not represented in our material, and we are still hoping to hear from some of these.

DESCRIPTION OF THE NORTH AMERICAN PLANT

As in other species of fungi sporophores originate from mycelium which ramifies in soil where warmth and moisture conditions meet the requirements of the plant. They may occur in rather large numbers in a sandy, adobe or semi-adobe soil, particularly after seasonal rains, in fertilized fields which are being reclaimed by irrigation, or where there is a free use of the garden hose; "never in silt (hard lands) or in alkali spots" (letter,

² Some plants received from Indio (2-3 mm.) could barely be distinguished from particles of soil.

Northrop). A clay river bottom in which the water dried out slowly was a favored locality in 1928 (Phoenix, Arizona, Edwards). Although this spot has been under observation, sporophores are not known to have reappeared.

Battle Creek Meadow in north central California marks the latitudinal limit of known range in the western hemisphere (two small sporophores, Jepson). The plant has been collected quite abundantly at El Centro, 65 feet below sea level, also in the Panamint Mountains in southeastern California at an elevation of five thousand feet (Hall and Chandler), indicating a wide altitudinal range.

Although *Podaxis* has been collected in every continent, Africa appears to be the center of maximum productivity; it is also found in the three groups of islands northwest of Africa.

While there are records that collections have been made in California in practically every month of the year, its active growing "season" here may be named as extending from April to October, the largest number of sporophores appearing usually in the months of May and June, or often later under the influence of the moisture supply. When the heat becomes excessive (125° F. in the shade), plants wither and cease to grow. Temperature at night during summer months is 80–90° F. (Indio, Smiley). An average day temperature in El Centro in September, 100–110° (Northrop).

Podaxis is a well developed plant while still underground, often attaining a growth up to three inches before breaking through to the surface. Its ability to push aside or lift heavy lumps of soil is notable. Its emergence above ground is said to take place usually during the night. When once above ground, growth takes place rapidly, from one to two inches daily until maturity is reached. Some "large" plants were reported as fully grown within a known period of ten days; also, one hundred and fifty plants were noted on a three-acre plot at one time (letter, Northrop).

While this fungus usually grows singly, there are instances of closely compacted sporophores up to nineteen in number, the bases being held firmly together by interlacing strands of mycelium and agglutinated soil (specimens, Clary). No reference has been found in any of the literature to this manner of growth.

The sporophore is differentiated into "foot," stipe and "head" even in very early stages of growth. The foot, invariably present, which suggested to Desvaux the generic name, consists of a solid mass of intermingled soil and hyphae which remains intact; slender, root-like processes—easily lost in collecting—issue from this irregularly enlarged base (PLATE 2, FIG. 1). The surrounding soil which has not been penetrated by hyphae is readily shaken off. We note that the larger the sporophore the larger the foot, and that what appears at times as a rather top-heavy plant is thereby provided with anchorage and balance in soil from which it might otherwise be displaced easily by heavy winds and seasonal, torrential rains. A study of soil habitat shows that *Podaxis* is primarily a sand plant, which, when finding conditions favorable elsewhere, *e.g.*, clay or adobe, continues to form hyphae and to accumulate soil. The fact that other species of fungi grown under different conditions acquire similar accumulations shows that this character is not peculiar to *Podaxis*.

The stipe inclusive of columella, up to twenty-six cm. in height (PLATE 6, FIG. 3), and up to one and one-half cm. in thickness—often described as "solid"—is found in young plants to be stuffed with a loose, floccose weft of parallel hyphae which extend to within three mm. of the lower end of the stipe (PLATE 3, FIGS. 3, 4). The columella continues to the summit of the peridium with which it is confluent by a narrow, fragile isthmus.

Attention is called to a variant form in which the columella fails to meet the peridium by one cm. (PLATE 5, A, FIG. 1). A single specimen of this type was collected in Indio, California (Smiley). Two other specimens are known, one in Patouillard's herbarium (Dodge), one in Cleland's, South Australia, no. 549 (5). It was Lloyd's opinion that such a plant might be entitled to generic rank; however, he made it a distinct species, calling it *Podaxon anomalus* (25, 992). It is identical with other plants in the same collection, except for the non-percurrent stipe. Inasmuch as these forms are so isolated and do not recur except as a rare variation, we are regarding them merely as "sports."

The stipe is frequently swollen in the region where it joins the margin of the peridium (PLATE 7, FIGS. 1, 3). Below the peridium the outer layers of the stipe are often lacerate horizontally, due to

the fact that they cannot keep pace with the more rapid growth taking place within (PLATE 5, A, FIGS. 1, 2).

A twist in the stipe (it may be left or right-handed), made the basis of a distinct species by Linnaeus, who was followed by subsequent botanists in this matter, is occasionally met (PLATE 3, a, b). A similar digression from the usual manner of growth has been observed in another sand plant of the Pacific Coast region—*Batarrea phalloides*³ (Dicks.) Pers. The twist occasionally met in these two genera may not be considered sufficient ground to establish distinct species.

The peridium, up to 10 cm. in width, often presenting a mica-like gloss, is differentiated into two layers; the outer splits into thin, ligulate scales which often hang out loosely in active stages of growth, giving the plant a very shaggy appearance. The scales at the summit are quite firm in texture and are more permanent. Frequently sporophores are of a beautiful, snowy whiteness (Frontispiece, Palm Springs, Clary); it has been suggested that chemical examination of soils might throw some light on the extraordinary variations in the color of the exoperidium.

The scaly character of the peridium impressed the mind of Fries when he characterized Ehrenberg's plant as "peridio squamoso, stilidio demum denudato, stipite tenuiore" (17, 1829, p. 62). When the plant is fully mature, all the scales are shed, revealing a dingy, ochre-colored endoperidium (PLATE 5, B). In fact, scalliness and smoothness—made the occasion for marking off species by some authors—simply indicate different stages of development or maturity.

The endoperidium—three to four mm. thick—from the inner surface of which are produced the "tramal plates" (1, p. 318; 14, p. 495) of the reproductive tissues, is firm and compact in texture.

The cylindric-elliptical chamber between the columella and the endoperidium is filled with a soft, pulpy glebal tissue which loosely spans the chamber. On "teasing out" these hymenial strands with a needle, they appear to be attached with equal firmness to the endoperidium and columella; in mature plants, however, these tissues are released first from the endoperidial wall and remain clinging to the columella, giving the appearance of a "bullrush" as suggested by Massee (27, 1890, p. 36), (see also PLATE 6, FIG. 5).

³ Edwards, Colton, California.

The gleba in youngest plants is white; it gradually turns yellow, and often takes on some Indian red tones—described by Berkeley as that of the substance called “crocus”—which also appear as patches in the outer layers of the stipe and peridium (2, 1845; 4, p. 291; PLATE 10).

There are only occasional evidences that deliquescence, noted in many Gasteromycetes, takes place here to a limited degree (PLATE 4, a, b).

MICROSCOPIC STUDY OF YOUNG PLANTS AND STUDY OF THE
PHOTOMICROGRAPHS

The glebal elements are complex and superimposed to such an extent that it is difficult to make out their structure. Fructifying tissues consist of hyaline, rope-like strands which span the glebal chamber from the columella to the endoperidium; these strands branch repeatedly, thus creating a multitude of labyrinthine inter-spaces. The basidia, arranged in globoid clusters, issue from closely adjacent points of attachment on the tramal strands (PLATE 10, B). This is an arrangement such as is depicted by Fischer (16, 1900, p. 333) in his description of *Phellorinia Delestrei* with this exception: he figures basidia of uniform size, whereas, in our plant, they show great variation in size. The above is an important item because it indicates that basidia reach maturity successively, as noted in other species of Gasteromycetes (Lycoperdaceae), also of Hymenomycetes (4, II, pp. 266–455).

Each ovoid cell shown in plate 10, B, was interpreted by Massee as a monosporous ascus, so that he came to the conclusion that “*Podaxis* is an Ascomycete” (27, 1890, pp. 33, 69).

Examination of fresh young material received from the Indio garden made by Doctor Lee Bonar did not substantiate Massee's claim. Dr. Bonar was able to demonstrate beyond the shadow of a doubt that *Podaxis* has spores borne on basidia and is therefore a Basidiomycete. The wall of a ripe basidium, and particularly the attachment of spores to the basidium, are characterized by extreme delicacy of structure. Several basidia with four smooth, sessile, hyaline spores, not arranged in perfect regularity on the apices, were found *in situ* by Dr. Bonar and viewed by the writer. In one instance only two spores could be found. If the question is

asked, "What becomes of basidia after abscission has taken place?" here is de Bary's answer: "basidia, having given up their protoplasm to the formation of spores, are usually dissolved by processes of decomposition not accurately known" (1, pp. 68, 310), (4, II, pp. 312, 313).

We now proceed to a consideration of an application of the principle of "successive generations," a subject so fully elaborated by Buller (4, II, pp. 244-359) in his study of Hymenomycetes. Just how many of the fascicled cells (PLATE 10, B) might have become fertile had the plant remained in the ground and continued to grow no one can say. Conditions might be so favorable that a plant might ripen most of its basidia, or only a small number might come to maturity. Basing judgment on the mass of spores in a well developed plant, we incline to the first possibility.

No literature is found to assist in an interpretation of the reproductive tissues shown in plate 10. Buller discusses "past, present, coming and future 'generations' of basidia in Hymenomycetes" (4, I, p. 63);⁴ there is undoubted evidence that a similar progressive ripening of spores takes place in this Gasteromycete. Very few spores are observed on a slide of very young material, more in older, and a limitless number in fully mature material. Our observations coincide with those of Fischer (16, 1900, p. 333), since he states that the sporophore of *Podaxis* matures from the base upward; also with those of Patouillard, who mentions that the ripening process takes place "graduellement" (28, 1890, p. 163). We may construe plate 10, B as indicating a "past generation" of collapsed basidia, because of the presence of ripe spores; no present generation as no spores are seen attached; also, "coming generations,"—immature basidia which were arrested in their growth when the plant was collected. Basidia in the same field of view present marked variation in size.⁵

Inasmuch as several seconds or even minutes may elapse between the shedding of a set of spores from a given basidium

⁴ He estimates that there are ten "generations" in *Panaeolus campanulatus* (4, II, p. 267). See also his studies of *Stropharia semiglobata* and *Agaricus campestris* (4, II, pp. 327-455).

⁵ A similar variation in size of basidia is figured by Maublanc and Malençon for *Battarraea Guicciardiniana* in Bull. Soc. Myc. Fr. 46: pl. 2 (1930), but not commented upon.

(Buller), it is possible to conceive—as ably demonstrated by Vokes (45) for a Hymenomycete—that spores may not necessarily be formed simultaneously in this Gasteromycete; of this there is indication but no proof. We may, therefore, postulate in *Podaxis* a perfected system of progressive ripening, existing not only in the glebal tissues throughout “from below upward,” but also maintaining in the formation of spores in each individual basidium.

In the same plate is shown a large, highly vacuolated, ovoid cell—an abnormally large basidium, $45 \times 24 \mu$.⁶ A number of these appeared in a mount in 50 per cent lactic acid; such pronounced enlargement has not been observed in other preparations, and apparently represents an extreme variation.

We stated that the spores⁷ in the material examined by us are sessile, the point of attachment making a scar (hilum); on it a fragment of the basidium may occasionally be seen hanging as a loose shred. Just opposite the point of attachment at the distal end there appears the single germ pore which appears hyaline by transmitted light, $2-2.5 \mu$ diam., ending in a flattened circular disc (PLATE 10, A, B), (1, pp. 100, 101, 111):

The spores, with an average $10-13 \times 10-15 \mu$, often present great variation in size (up to 36μ long), also in shape (pear shaped, centrally constricted, irregular), not only in a single plant but even in a single mount (PLATE 10, A, B). Each spore is provided with a double integument which is colorless at first; the inner layer gradually takes on a garnet-brown tone (a yellowish-reddish brown) (33), and later a rich mahogany tone (“rouge acajon,” 28, 1890, p. 166). The yellow tone is derived from the protoplasmic content of the spore, which appears to hold granular material in suspension (4, I, p. 7; II, p. 304).

Spores *in situ* may be viewed only in young material, either fresh or preserved in fluid, and even then very rarely, in the ex-

⁶ Considered “normal” by C. W. Dodge. See addendum.

⁷ Dodge figures definite sterigmata on basidia in the American plant (14, 1931). Wakefield finds in our material “a slight neck which may be regarded as a suggestion of an abbreviated sterigma.” [Patouillard figures short sterigmata for *P. arabicus* (28, 1887).] These extraordinary variations in the attachment of spores to basidia—from sessile to short neck—to definite sterigmata—observed in young material from a single collection from the Indio garden plot, furnish additional evidence to the single-species argument, considered in comments on published species.

perience of the writer. Lack of such material accounts for the taxonomic difficulties mentioned by de Bary (1, p. 317), and by Berkeley (2, 1857, p. 349).

It should be stated that whereas spores in Basidiomycetes may usually be seen to increase in size at the apices of basidia, we have seen only fairly good sized spores even in young material and no suggestion of sterigmata. Repeated efforts have been made to secure a germination of the spores of *Podaxis* in water, by subjecting them to temperatures ranging from 20° C. to 30° C., over varying periods of time, but without success.

CAPILLITIAL THREADS IN *PODAXIS*

These may be observed stretching irregularly in the trama of the glebal strands. They are free from the other glebal tissues, but are attached to the columella and to the endoperidium. They vary in diameter from 3.5 to 8 μ , average 5-6 μ (24 μ). They are abundant in material which is taken from near the central columella, less abundant if taken from near the endoperidium and frequently are altogether lacking elsewhere. In young plants the threads are hyaline, cylindrical, fairly straight, rarely septate or branched, and show not even the slightest indication of a spiral structure. In older plants the threads begin to take on garnet-brown tones, often become flattened and ribbon-like, and occasionally show distinct indications of a spiral within the wall. It seems necessary to emphasize these differences in the thread due simply to age, and marking different stages in its development, because they have been made the basis by different authors for segregating plants into species.

All that we have said descriptive of the thread in North American material applies to all foreign material except *Podaxon carcinomalis* Fries, from South Africa, in the Kew Herbarium (PLATE 12, A, B). This thread is thick-walled, somewhat rigid, deeply colored, varies in width from 6 to 19 μ , is occasionally branched and very much entangled. Only rarely does it separate along the lines of the striae, producing an open spiral. The same mounts used in the preliminary study were examined anew some months later, and the spirals then appeared to have straightened into "ribbons" (de Bary).

Berkeley (2, 1845) examined the Linnaean material of *Podaxis* and found nothing "unusual" in the thread of *L. pistillare* L., but he did find a spiral "here and there" in *L. carcinomale* (both in an excellent state of preservation in the Linnaean Society's rooms in London). We have found no thread in our twelve collections from South Africa comparable to that in the material received from Kew, which, accordingly, as far as our observations extend, is an unusual variation. This variation, however, is one of degree and not of kind. We have abundant evidence that *all* capillitial threads grow on spiral rather than on longitudinal lines, and are inclined to believe that we have here simply a more advanced state of maturity than has been met elsewhere.

Another type of thread—long, slender, straight, hyaline, like that in our American plants, was found in this very mature material (PLATE 12, A). The observations of the writer correspond with those of de Bary, who also found two aspects of the thread in one and the same plant—"Podaxon pistillaris," some with rather thin, yellow walls, which flatten into ribbons, others with thick, yellowish-brown membranes which readily tear into spirals" (1, p. 318). The variation described simply represents different degrees of development.

The thread in the material, which came to us from South Brazil by courtesy of Professor Thaxter (PLATE 12, C), reveals a spiral thickening in the wall, and looks like a silken cord which, over-twisted, doubles back on itself rope-like (PLATE 12, C). This aspect of the thread is an exact counterpart of that observed in the South African material received from Wakefield.

We find, therefore, no reasonable ground for segregating into species the plants examined because of distinctions in the capillitial thread.

For function of thread see Massee (27, 1890, 1906), also Gynn-Vaughn, 1927. It is now generally conceded that *one* of the functions of the capillitial thread is to assist in the dissemination of spores.

⁸ Herbarium at Berlin, marked Schweinfurth, no. 275.

CITATION OF NORTH AMERICAN MATERIAL EXAMINED

Localities:

1. Bampo, Sonora, Mexico, type material of *Podaxon mexicanum* Ellis, Palmer, 1890. J. A. Stevenson.
- 2.* Phoenix, Arizona, McClatchie, 1898.
3. Calexico, Imperial Valley, Abrams, no. 3988, 1903.
- 4.* Along the Colorado River, Palo Verde, Hall and Greata, April, 1905.
- 5.* Panamint Mountains, 5000 feet elevation, Hall and Chandler, May, 1906.
6. Sonora (Mexico), November, 1908, determined *P. Farlowii* by Patouillard, Muséum d'Histoire Naturelle, Paris. R. Heim.
- 7.* Imperial Valley, three collections, Bridwell, June, 1912.
- 8.* Colorado River, near Needles, Rixford, 1913.
- 9.* Yuma, Arizona, Hall, September, 1920.
10. Arizona, October, 1922, determined as *P. mexicanum* Ellis, by V. K. Charles. Smithsonian Institution, Washington, D. C.
11. Indio, California, Clark, June, 1926. From A. Eastwood.
12. Indio collection, J. L. Griffin, October 14, 1929.
13. Indio and Coachella Valley, approximately fifty specimens, Smileys, 1929-31.
14. El Centro, California, approximately three hundred specimens, Northrop, 1929-32.
15. Indio, Coachella Thermal and Palm Springs highways, also Mecca (40 miles east of Palm Springs area) over fifty specimens, Clarys, 1931.
16. Old Desert Road, Florence to Phoenix, Arizona; Casa Grande district, Phoenix, also Calexico, Edwards, 1929-31. Specimens reported, road from Mecca to Blythe, winter, 1932.
17. Casa Grande National Park, Coolidge, Arizona, C. P. Russell, March 1, 1932.
18. Santa Rosa Mountains, below Mt. Martinez; also, Coachella Valley, west of Narbonne Ranch, B. L. Clary, March 8, 1932.

* Herbarium, University of California.

19. Coral Reef Ranch, Coachella, California, B. Harwell, March 8, 1932.
20. East of Baker, near Mohave Desert, Mrs. G. E. Kelly, March 22, 1932.

CITATION OF FOREIGN MATERIAL EXAMINED

1. *Podaxon carcinomalis* Fries, "on ant hills," Uitenhage, Zeyher, no. 99, det. Berkeley, Royal Botanic Gardens, Kew, England, E. M. Wakefield.
2. *P. "carcinomatis"* Fries, Cap-de-Bonne-Espérance, coll. de Drège, det. Léveille (puis Tulasne), no. 9454d, Muséum d'Histoire Naturelle, Paris, R. Heim.
3. *P. "carcinomatis"* (L.) Fries, same locality and collector, det. Hariot (apr. Léveille et Tulsane), Muséum d'Histoire Naturelle, Paris, R. Heim.
4. *P. aegyptiacus* Mont., "Sahara occidental, Avril, 1923," Université d'Alger, R. Maire.
5. *P. aegyptiacus* Mont., "in arenosis, Avril, 1928, no. 1503," Université d'Alger, R. Maire.
6. *P. arabicus* Pat., "Sahara occidental, Avril, 1923," Université d'Alger, R. Maire.
7. *P. carcinomalis* Fries, "Garstfontein, Pretoria Dist., Transvaal, Apr., 1911." No. 1689, Union South Africa, Dept. Agr., A. M. Bottomley.
8. *P. carcinomalis* Fries, Kroonstad, Orange Free State, December, 1930. No. 5585, Union So. Africa, Dept. Agr., A. M. Bottomley.
9. *Podaxis carcinomalis* (L.) Desv. (one specimen in formalin and one dried). University of Cape Town, E. L. Stephens.
10. *Podaxon* sp. "from ant heap, Transvaal, So. Africa, March, 1926." University of the Witwatersrand, Johannesburg, E. M. Young.
11. *Podaxon* sp. "Ant heap, Johannesburg, June, 1927." University of the Witwatersrand, Johannesburg, E. M. Young.
12. *P. carcinomalis* L. var. *minor*, det. Lloyd, Pretoria, So. Africa, 27-2-21. J. A. Stevenson, Dept. Agriculture, Washington, D. C.

- 13.⁹ *P. carcinomalis*, Univ. Stellenbosch, Union So. Africa. P. A. van der Bijl.
14. *P. carcinomalis*, "from S. Africa, MacOwen, Herb. Patouillard." Farlow Herbarium, Cambridge, Mass., R. Thaxter.
15. *P. carcinomalis* (L.) Fries, Is. of Maui, Hawaii, Shear and Stevens, Jan. 6, 1928.
16. *Podaxon* (?) "from termite nests in S. Brazil, von Höhnelt, 1902." Farlow Herbarium, Cambridge, Mass., R. Thaxter.
17. *Podaxon* (?) "Kingston, Jamaica, Hitchcock no. 7, in *carcinomalis* cover." Farlow Herbarium, Cambridge, Mass., R. Thaxter.
18. *Podaxon squamosus* "from Patouillard's herbarium." The New York Botanical Garden, New York City.
19. *Podaxis pistillaris*, Cape Verde Is., det. Masee. The New York Botanical Garden, New York City.

TABULATION OF GENERA AND SPECIES WHICH HAVE BEEN
PUBLISHED

1. *Lycoperdon pistillare* L.¹⁰ Mant. Pl. 313. 1771.
2. *Scleroderma pistillare* Pers. Syst. Fung. 150. 1801.
3. *Schweinitzia pistillaris* Grev. Edin. Phil. Jour. 8: 256-258, pl. 6. 1822-23.
4. *Cauloglossum pistillare* Grev. Scottish Crypt. Fl. 1: 60. 1823.
5. *Podaxon pistillaris* Fries, Syst. Myc. 3: 63 (described by Berk. Lond. Jour. Bot. 4: 291-293. 1845). 1829.
6. *Lycoperdon carcinomale* L. Spec. Pl. Supp. ed. 13, C. L. fil. 453. 1781.
7. *Scleroderma carcinomale* Pers. Syst. Fung. 153. 1801.
8. *Schweinitzia carcinomalis* Grev. Edinb. Phil. Jour. 8: 256-268. 1822-23.
9. *Cauloglossum carcinomale* Grev. Scottish Crypt. Fl. 1: 60. 1823.
10. *Podaxon carcinomalis* Fries, Syst. Myc. 3: 62. 1829.

⁹ "The only *Podaxon* known in the Union." Letter to Bonar, April 28, 1930.

¹⁰ Linnaeus (1771) credits Boccone with a knowledge of this plant, refers to it as "fungus clavatus albicans, italicus pistillaris, sed colore differt." (See *Musea di Fisica e di Esperienze*, plate 307, 1668); also Koenig, who published in 1680, also Tournefort (1694) who quotes Boccone (40).

11. *Podaxon carcinomalis* var. *minor*, Jour. Bot. 28: 75. 1890.
12. *Lycoperdon axatum* Bosc, Act. Soc. Hist. Nat. Paris 1: 47, pl. 11. 1792.
13. *Podaxis axata*. Attributed to Bosc by Massee, Jour. Bot. 28: 75. 1890. Also by Cooke. 1892.
14. *Podaxis senegalensis* Desv. Jour. de Bot. 2: 97. 1809.
15. *Cionium senegalensis* Spreng. Syst. Veg. 4: 529. 1827.
16. *Mitremyces indicus* Spreng. Syst. Veg. 4: 518. 1827.
17. *Podaxon indicus* Spreng. Syst. Veg. 5: 518. 1828. (26: p. 88.)
18. *Podaxon calypttratus* Fries, Syst. Myc. 3: 62. 1829.
19. *Podaxon calypttratus* var. *minor* Cooke. 1879.
20. *Podaxon aegyptiacus* Mont. Ann. Sci. Nat. II. 20: 69. 1843.
21. *Cauloglossum aegyptiacum* Zobel in Corda, Ic. Fung. 6: 18. 1854. (Zobel lists *P. aegyptiacum* Mont. as a synonym.)
22. *Podaxon loandensis* Welw. & Currey, Trans. Linn. Soc. Lond. 26: 279-94, pls. 19, 20. 1850-1861.
23. *Podaxon elatus* Welw. & Currey, Trans. Linn. Soc. Lond. 26: 288, pl. 19, f. 4-6. 1850.
24. *Podaxon mossamadensis* Welw. & Currey, Trans. Linn. Soc. Lond. 26: 288, pl. 19. 1850.
25. *Podaxon mossamadensis* var. *Emini* Henn. Fung. Afr. II, p. 38 (See Sacc. Syll. Fung. 11: 158). 1893.
26. *Podaxon Warnei* Peck, Bull. Torrey Club 9: 2. 1882.
27. *Podaxon Emerici* Berk. (as per Mass.) Jour. Bot. 28: 77. 1890.
28. *Podaxon arabicus* Pat. Bull. Soc. Myc. Fr. 3: 122, 123, pl. 11, f. 1, 2, a; *ibid.*, 6: 166, 167, pl. 17, f. 3. 1887.
29. *Podaxon Deflersii* Pat. Bull. Soc. Myc. Fr. 6: 165, pl. 17, f. 1. 1890.
30. *Podaxon Schweinfurthii* Pat. Bull. Soc. Myc. Fr. 6: 165, pl. 17, f. 2. 1890.
31. *Podaxon squamosus* Pat. Bull. Soc. Myc. Fr. 7: 210, pl. 13. 1891.
32. *Podaxon Perraldieri* Pat. Cat. Pl. Cell. Tunisie 68. 1897.
33. *Podaxon Chevalieri* Pat. & Har. Champ. Senegal, Jour. Bot. 14: 241, pl. 7. 1900.
34. *Podaxon algericus* Pat. Bull. Soc. Myc. Fr. 20: 53, pl. 5. 1904.

35. *Podaxon Glaziovii* Henn. Hedwigia 36: 210. 1897.
36. *Podaxon ghattasensis* Henn. Hedwigia 37: 287. 1898.
37. *Podaxon Gollani* Henn. Hedwigia 40: 338. 1901.
38. *Podaxon Mülleri* Henn. Hedwigia 43: 187. 1904.
39. *Podaxon mexicanum*¹¹ Ellis, Jour. Myc. 7: 274. 1893.
40. *Podaxon argentinus* Speg. Anal. Mus. Nac. Buenos Aires 6: 186. 1899.
41. *Podaxon patagonicus* Speg. Anal. Mus. Nac. Buenos Aires 6: 186. 1899.
42. *Podaxon macrosporus* Speg. Anal. Mus. Nac. Buenos Aires 16: 27, cum icon. 1906.
43. *Podaxon strobilaceus* Copeland, Ann. Myc. 2: 4, pl. 1, f. 7. 1904.
44. *Podaxon termitophilus* Jumelle & Perrier, Compt. Rend. Acad. Paris 145: 274; Sacc. 21: 469. 1907.
45. *Podaxon anomalus* Lloyd, Myc. Writ. 6: 992. 1920.
46. *Podaxon* sp. Jamaica. Farlow Herb. (Hitchcock). 1891.
47. *Podaxon* sp. So. Brazil. Farlow Herb. (von Höhnelt Herb.).
48. *Podaxon Ferrandi* Mott. Somalie, Africa. Patouillard's Herb. (Thaxter).
49. *Podaxon Paoli* Berk. (?) Canary Is.
50. *Podaxis Farlowii* Masee, Jour. Bot. 28: 77. 1890.
51. *Podaxon Farlowii* form *gracilis* Pat. Mexico. 1908.
52. *Podaxis pistillaris* (L.) Fries, Comp. Morph. Fungi, Gäumann-Dodge. 1928.

COMMENTS ON THE ABOVE

- 1, 6. *Lycoperdon pistillare* L. (1771). From East India. The first description of the plant reads: "clavatum, stipite torto, fungus spithameus, croceus. Stipes basi ovata, cylindricus, totus fibris longitudinalibus tortus. Clava terminalis ovato-oblonga, stipite quadruplo craffior, duplo longior, vestitus membrana crocea, repleta pulvere ferrugineo. India, Koenig." The species *L. carcinomale*, published ten years later (1781), is described as clubbed, stipe cylindrical, straight (cancerous); Cape of Good Hope. *Thunberg*; both, dusty, rooted, replete with farinaceous seeds.

¹¹ Error in ending of specific name.

Miss E. M. Wakefield describes the Linnaean material as follows: "*L. pistillare* is a small plant, with a slender, twisted stem, which suddenly expands into a sandy, bulbous base. The peridium occupies a relatively small proportion of the stem, and is distinctly dark, red-brown in color. It is a peculiar color, not at all rusty. In *L. carcinomale* the stem is stouter, and is more gradually thickened downward. The peridium occupies about half the height of the stem and is umber-brown, with no hint of red. Microscopic examination was not allowed." (Letter, October 9, 1931.) For Berkeley's examination of capillitial threads in the Linnaean material see page 10.

Specimens of the American plant with straight and twisted stipes may be found growing side by side. Probably the Linnaean plants are one species, *P. carcinomalis*, a little more mature (See Berk.'s detailed description of *P. pistillaris*, 1845).

- 2, 7. Persoon (1801) retained Linnaeus' two species, but placed them in another genus, *Scleroderma*. Providing Persoon's material were without scales, very mature and well-weathered like our Phoenix, Arizona, specimens, it might readily have suggested to him that genus.
11. *Podaxon carcinomalis* var. *minor* is ascribed to Berkeley by Massee. This name was not published by Berkeley,¹² neither does it appear in the manuscript index to his herbarium.
12. *Lycoperdon axatum* Bosc (1792) = *P. calyptratus* Fries, from an island in the Sénégal River, West Africa (39, p. 362). Following is Bosc's description:

"*Lycoperdon stipitatum*, clavatum, stipite torto lignoso ad apicem clavae praelongo, clava lateribus lacérato-déhiscente. Habitat ad Sénégalém fluvium.

Racine tubéreuse, oblonguè, terminée par un prolongement.

Tige fistuleuse, d'une substance presque ligneuse dont les fibres se contournent de gauche à droité. Cette tige se prolonge jusqu'au sommet de la tête.

Tête ovale, de quatre pouces de long sur deux de large,

¹² Letter, E. M. Wakefield, May 6, 1930.

entourant la partie supérieure de la tige. La membrane extérieure se fendant, au moment de la maturité, dans plusieurs endroits des parties latérales inférieures, pour laisser échapper les semences. On remarque au sommet de cette tête deux ou trois membranes ovoïdes, irrégulières, qui ne sont attachées que par un point, mais qui restent appliquées à la surface. Elles sont les restes du volva.

Semences de même nature et de même couleur que dans le *L. bovista*. Elles sont arrêtées dans un réseau fixé à l'axe de la tête. Ce réseau ne paroît attaché en aucune manière à la membrane extérieure.

Le *Lycoperdon axatum* a environ un pied de haut d'une de ses extrémités à l'autre. Sa couleur est d'un gris blanchâtre semblable à celle du *Lycoperdon pedunculatum*. Il paroît avoir des rapports avec le *Lycoperdon pistillare* et le *Lycoperdon carcinomale*. Il présente des caractères qui n'ont pas encore été observés dans les champignons, tels que le prolongement de la tige jusqu'au sommet de la tête, et le déchirement latéral de cette même tête pour la dispersion des semences. Il semble faire le passage entre les *Lycoperdon*, les *Clathrus* et les *Clavaria*.

Cette belle espèce a été trouvée par M. Roussillon dans une petite île sablonneuse du fleuve Sénégal, peu éloignée du comptoir français. Elle fait partie des richesses botaniques et zoologiques que ce zélé naturaliste a rapportées d'Afrique.

La figure de la Planche VI représente ce champignon de grandeur naturelle, mais par erreur du graveur, les fibres sont contournées en sens contraire de ce qu'elles doivent être.

On observe que la racine ne paroît si grosse, que parce qu'elle est entourée d'un sable fortement agglutiné, au moyen d'une liqueur visqueuse."

Bosc wished to emphasize the character of the stipe elongated as an axis into the peridium. All characters listed in his detailed description are identical with those of an American plant with twisted stipe. Probably a justifiable reduction here. He interpreted the scales closely adherent at summit of peridium as remnants of a volva!

13. *Podaxis axata*, from New South Wales, based on scanty capillitium, is ascribed to Bosc and so published by Massee and Patouillard (1890), also by Cooke (1892). We do not find that Bosc ever used this combination; possibly it is

an unpublished name of Bosc which may be quoted as *P. axata* Bosc (*fide* Massee, Patouillard and Cooke).

- 3, 4, 8, 9. Greville (1822) was not satisfied with either of the generic names *Lycoperdon* or *Scleroderma*; he states that if Persoon had dissected his plant, he could not have placed it in *Scleroderma*. Accordingly he proposed the genus *Schweinitzia*, retaining Linnaeus' and Persoon's two species. He had his misgivings, however, as to the validity of *S. carcinomalis* (from Cape of Good Hope, in mounds of termites), asking, "an species distincta?" (18, 1822, p. 258). Like Bosc he emphasized percurrent stipe and mode of dehiscence. Finding his generic name preoccupied by Elliot's genus of phanerogams, he changed the name to *Cauloglossum* in 1823, apparently in ignorance of Desvaux' name (18).
14. Desvaux (1809) based his *Podaxis senegalensis*, from the banks of Sénégal River, on Bosc's plant. He gives a detailed description, stipe twisted from left to right, peridium double, mentions attachment of columella to peridium, also deals with relationships and taxonomic position. It appears that Desvaux was not justified in ignoring the various specific names which had been proposed by other authors. The description indicates such a full correspondence with the American plant that we feel justified in specific reduction. The new generic name is descriptive and satisfactory.
15. Sprengel placed Desvaux' plant in *Cionium* as *C. senegalensis* (Desv.) Spreng. It is stated by Fries (17, p. 63), also by Streinz (39, p. 454) to be equivalent to *P. calyptratus*, which our plant blankets. Though we have not been able to refer to Sprengel's text, reduction seems to be justified.
- 16, 17. *Mitremyces indicus* Spreng., later called by him *Podaxon indicus* (26, p. 88) = *P. pistillaris* (39, p. 455) has been described by numerous authors; their descriptions tally so perfectly with some of our plants that it appears reasonable to reduce it.
- 5, 10, 18. Fries (1829) renamed Bosc's plant as *P. calyptratus*, also cited the figure "ad Senegal fluvium (*v. ic.*)," implying that he had not seen a specimen; he ascribed the

twisted stipe character of *P. pistillaris* also to this species, adding for characterization a removable peridium and exceptionally massive base; He made *P. carcinomalis* inclusive of tall, straight-stemmed plants, and *P. pistillaris* of shorter, stocky plants.

19. *Podaxon calyptratus* var. *minor* Cooke. Very small plants with peridia, which in the ripe state can be lifted off intact, occur very frequently in our material.
20. *P. aegyptiacus*¹³ Mont. Two specimens determined by Dr. Maire and sent to us have the same irregularity in size and shape of spores as our small plants from Indio, California.
21. *Cauloglossum aegyptiacum* Zobel. Zobel published this species twelve years after Corda's death, stating that he received his material from Montagne. He described and figured the plant as having a volva, a single-layered peridium with dehiscence at the sides. This plant must belong in some other genus not *Cauloglossum* Grev.
22. *Podaxon loandensis* Welw. & Currey, no. 115, suggests our tall slender plants with twisted stipes. "Paulo post primas pluvias adparet."
23. *Podaxon elatus* Welw. & Currey, no. 148, 31 cm. tall (Saccardo) must have been the most massive of the West African plants collected by Welwitsch and Currey. They record capillitium sometimes spirally ruptured.
24. *Podaxon mossamadensis* Welw. & Currey, no. 149, is described as a smaller plant. Every character mentioned in the descriptions of their three species is found in the American plant; also verified by good figures. The authors mention absence of spiral markings in the thread, and state that these vary according to age of the plant. Spores $10\ \mu$ diam.
25. *Podaxon mossamadensis* var. *Emini* Henn. From Central Africa. No check. Spores $8-12 \times 6-8\ \mu$.
26. *Podaxon Warnei* Peck. Later referred by Peck to *Secotium Warnei* (29, 1882), really belongs in *Endoptychum*, not closely related to *Secotium*. In wrong genus (letter, Dodge).

¹³ L. E. Melchers records seven species of *Podaxis* in Egypt. See Trans. Kansas Acad. Sci. 34: 61, 1931.

27. *Podaxon Emerici* Berk. Described by Massee as containing both basidiomycetous and ascomycetous fructification. We are unable to check this point in *P. Emerici*, but Massee's claim is not supported by the findings of more recent workers. We find the fascicled arrangement of basidia in the American plant perplexing and one which we can understand might have been interpreted by Massee as consisting of monosporous asci. In fact, C. W. Dodge calls attention to a fascicled arrangement of asci frequently met in many groups of Ascomycetes, e.g., *Mesophellia*.¹⁴ That there are basidia in *Podaxis*—confirmed by several mycologists—may be definitely alleged; that there is also ascomycetous fructification as published by Massee has never been demonstrated.

Patouillard classified fifteen¹⁵ species and two forms (seven "new," three from America), according to color or absence of color in the basidia ("basides"). This procedure has been found to be ill-advised, because color in the fructifying parts is entirely dependent on the age of the plant. No item appears in any of his descriptions, including spore measurements, which is not covered by our American material.

28. *Podaxon arabicus* Pat. Canal in columella was noted, capillitium colorless, scanty, spores subglobose or ovoid, spores $11-12 \times 8-9 \mu$.
29. *Podaxon Deflersii* Pat. "Capillitium nul." Patouillard notes short sterigmata. Spores $10-12 \times 6-9 \mu$.
30. *Podaxon Schweinfurthii* Pat. "Ecailles appliquées." Gleba yellow, later orange-red. Small hilum visible. Spores $11-16 \times 8-10 \mu$.
31. *Podaxon squamosus* Pat. From Egypt, Arabia, Syria. Stipe longitudinally striate, a slender plant, close to *P. carcinomalis*, capillitium a spiral ribbon, colorless. Basidium four-spored; spores subsessile, truncate at apex, with single pore. Spores $10-12 \times 8-9 \mu$.

¹⁴ Letter. March 9, 1932.

¹⁵ Lloyd remarked facetiously that there appeared to be as many species of *Podaxis* as collections!

32. *Podaxon Perraldieri* Pat. "Columella percursa." "Capillitium non spiraliter." "*P. indico* Fries affinis." "In sabulosis (gravel) in Tunisia." Spores $14-15 \times 10-12 \mu$.
33. *Podaxon Chevalieri* Pat. & Har. "Capillitio non spiraliter." From "Tombouctou," West Africa. Characterized as "eximia species" by Saccardo. Spores $12-13 \times 8-10 \mu$.
34. *Podaxon algericus* Pat. Based on small sized plants and on changing colors in the gleba. His figure shows a perfectly white gleba (plant young) except in the region where peridium meets the stipe (change in color starts there). Basidia 2-4 spored. Spores $10-12 \times 9-10 \mu$.
35. *Podaxon Glaziovii* Henn. From Brazil. No characters named in the text distinct from those of the North American plants. Spores $9-12 \times 8-10 \mu$.
36. *Podaxon ghattasensis* Henn. From Central Africa. Resembles *P. elatus* Welw. & Currey. No distinguishing characters listed. Spores $12-14 \times 7\frac{1}{2}-8\frac{1}{2} \mu$.
37. *Podaxon Gollani* Henn. A very small slender plant from the Sahara Desert. Spores $10-12 \times 8-10 \mu$. There is a possibility that the specimen determined by Lloyd as *P. carcinomalis* var. *minor*, from Africa may be identical.
38. *Podaxon Mülleri* Henn. From Goscogne River, Australia. No distinguishing character. Spores $10-16 \times 10-12 \mu$.
39. *Podaxon mexicanum* Ellis. Gleba from his type specimen shows exact correspondence with our plant; also, his detailed description fits perfectly. In describing this "new" species, Ellis appears to have ignored the work of his predecessors and contemporaries. Spores $8-12 \mu$ diam. (12-15).
40. *Podaxon argentinus* Speg. Spores very small, $4-5 \mu$ diam. No check on this plant. We might expect another species here.
41. *Podaxon patagonicus* Speg. Very low in stature, spores slightly larger than those in no. 40, $5-6 \mu$ diam. He suggests that this might be a "variety" of the above. (Our specimens from northern latitudinal range are also small, but show no microscopical differentiation.)
42. *Podaxon macrosporus* Speg. Spores larger, $14-18 \times 7-12 \mu$,

blanketed by our plant. Habitat, arid stony hills called Zonda, "prope San Juan Argentinae." Sacc. Syll. Fung. 21: 468, 469. 1912.

44. *Podaxon termitophilus* Jumelle & Perrier. From Madagascar, occurring in nests of termites.¹⁶ "Basi inflato," related to *P. carcinomalis* and *P. squamosus*, differing from them chiefly in the color of the spores (Sacc.).

Plants described and figured by Verwoerd (44), showing several specimens toward the summit of an immense termite mound, could readily be mistaken in general appearance for American plants. Spores $12 \times 9 \mu$.

45. *Podaxon anomalus* Lloyd (25, 1920, fig. 1776). To be regarded as a "sport" and not as a distinct species. "No true capillitium." "Spores $10-12 \times 12-14 \mu$ " (Lloyd). See description, p. 4, also PLATE 5, A1.

46. *Podaxon* sp. From Jamaica. We have examined gleba and it shows no character which distinguishes it from other North American material examined. It is of interest because it represents a transitional locality between the two western continents.

- 47.¹⁷ *Podaxon* sp. from South Brazil.

- 48.¹⁷ *P. Ferrandi* Mott, from Abyssinia.

- 49.¹⁷ *P. Paoli* Berk. (?) Canary Islands.

50. *Podaxis Farlowii* Massee. Massee classified seven species according to a scarcity or abundance of capillitium. The amount of capillitium depends on the age of the plant and on the place in the glebal chamber from which material is taken, as previously explained.

The "new" species erected for the American plant is characterized by him as having "peridium broadest at the apex, stem slightly or not at all swollen at the base, capil-

¹⁶ That there is any association between *Podaxis* and termites—Massee mentions "fungus-gardens" in this connection—seems improbable; a habitat of this kind has been rarely mentioned.

The fungus is said to be eaten by natives in Africa and Afghanistan, also said to be applied by them to cure cancerous sores (Linn.), *carcinoma* = cancer; called "Kraaisnuif"—crows' snuff—in South Africa (letter, Stephens).

¹⁷ These are known to us only by name.

litium threads very rare, spores 10–12 or $10 \times 12 \mu$, Arizona, Palmer" (27, p. 76). This characterization is inadequate and the claim for a "new" species is not supported by comparative studies. There is a possibility that the spores in our plants may average slightly broader and have greater brilliancy than those in our foreign material; however, the writer does not find such variations a sufficient basis for segregating into species, as previously stated.

Harkness (1880) published two species from the Colorado Desert. Lloyd reiterated that we have one species only—*P. Farlowii*; a collection in the Farlow Herbarium, originally named *Podaxon carcinomalis* by Farlow was later changed to read: *P. Farlowii*.¹⁸

51. *P. Farlowii* form *gracilis*¹⁹ Pat., from Mexico.
52. *Podaxis pistillaris* (L. ex Pers.) Fries. Comprehensive of all the plants studied. This combination, which we believe is correct, has already been used by Gäumann-Dodge (1928). For adoption of *Podaxis* as a generic name see a subsequent topic. Fries' orthographic correction is allowed, see Rule 24, last clause, Art. 57.²⁰ Persoon's name is introduced because his Synopsis, 1801, is the starting point of nomenclature. See Rule.

EXCLUDED:

21. *Cauloglossum aegyptiacum* (Mont.) Zobel probably should be referred to some other genus. Zobel added for characterization of genus—"fungi volvati vel velati"—not proposed by either Greville, author of the genus, or by Corda or Fries when they published it. See page 19.
26. *Podaxon Warnei* Peck belongs in *Endoptychum* Czern. See footnote, p. 25.
43. *Podaxon strobilaceus* Copeland seems to be *Gyrophragmium Delilei* Mont. (= *G. decipiens* Peck).

Notes: 1. This fungus has been described under eight generic names: *Cauloglossum*, *Cionium*, *Lycoperdon*, *Mitremyces*,

¹⁸ Letter, Thaxter, April 24, 1930.

¹⁹ Known to us only by name.

²⁰ Règles Internationales de la nomenclature rédigées par John Briquet, Jena: Gustav Fischer, 1912.

Podaxis, *Podaxon*, *Schweinitzia*, *Scleroderma*. 2. Saccardo records the descriptions of twenty-five species inclusive of one variety.

PREFERENCE FOR PODAXIS AS A GENERIC NAME

Of the two generic names, *Podaxis* Desv. (1809) and *Podaxon* Fries (1829), the latter, it must be admitted, is in more common use. It has been aptly said that a scientific name is really only a symbol. We use Desvaux' cleverly devised name because of its priority claim of twenty years, and are not alone in so doing (Dodge, Massee, Cooke). It was Fries' notion that a name might not be derived from two languages (in this case Greek and Latin), and he accordingly states that "nomen *Podaxon* scribendum est" (17, 1829, p. 62). This opinion is not supported by the practice of recent botanists and mycologists in all cases. Inasmuch as it is generally conceded that priority is the underlying principle of all botanical nomenclature, that Gasteromycetes are usually referred to the authors who preceded Fries, and as many hybrid²¹ words have found their way into standard dictionaries, *Podaxis* is retained as a generic name.

AFFINITIES

*Phellorinia*²² Berk. "gen. nov." (Lond. Jour. Bot. 2: 421) is the nearest known relative of *Podaxis*.

Members of this genus are distinguished from those of *Podaxis* chiefly because stipes are not percurrent. The arrangement of fascicled basidia in both genera, as described and figured by Fischer (16, 1900), suggests the hymenium of *Alpova* (14). See also Cooke for *Xylopodium* (9, 1892, p. 242, pl. 16, f. 123).

It has been stated by several authors, Hollós, Fischer, Peck, Saccardo, Lloyd, Coker and Couch, that *Phellorinia* occurs in southwest United States. Peck describes *P. californica* sp. nov. from two small specimens collected by S. B. and W. F. Parish in the Mohave Desert (north of Colorado Desert), 1882, "shaped like a broad wine glass" (29, 1890).

We have from H. E. Roberts one specimen of *P. macrospora*

²¹ E.g. *Pseudotsuga*, *Hesperoyucca*, anglophobia, automotive, aeroplane.

²² Incl. *Xylopodium* Mont. (16, 1900, p. 334). See also Grevillea 15: 95.

Lloyd, collected from the Mohave Desert, near Needles, April 17, 1931 (see Lloyd, 25, 1913, Letter 44, note 50).

Lloyd states that *P. inquinans* Berk. has been collected in Australia, Tunis, Texas, California. He claims that there are only two species of *Phellorinia*, *P. Delestrei* Dur. & Mont. and *P. strobilina* Kalch.—“among the rarest of Gasteromycetes.” We have received from our foreign correspondents (Cleland, Australia; Stephens and Bottomley, So. Africa) specimens which appear to represent two distinct species, which with our own from the Mohave Desert make three in our collections. Fischer states that there are nine species of *Phellorinia*; Saccardo records four.

Chainoderma Massee. *C. Drummondii* is described by Cooke (9, 1890, 19: 46; 1892, p. 221) as occurring near the Swan River, Australia; a small plant, 5–6 cm. tall by 1.5 cm. wide, stipe percurrent, peridium never released from the stipe, “remains of stigmata usually persistent.” Our depauperate, undeveloped forms of *Podaxis* from the Colorado Desert (PLATE 3, c) fit their descriptions in every particular. Such forms appear to be the result of excessive heat and diminished moisture supply. These stunted, dwarfed plants suggest the possibility that *Chainoderma* is not a valid genus. No reference appears to have been made to the genus either by Cleland or Lloyd in listing Australian fungi. It is described by Fischer.

TAXONOMIC POSITION OF *PODAXIS*

Nothing conclusive may be said concerning the taxonomic position in a phylogenetic scheme. *Podaxis* appears to be an aberrant genus, represented by a single species, possessing characters of several groups. It may have arisen, via *Leucogaster* and *Alpova* from the Ascomycetes—from a white-spored group of Plectoforms which are distinguished by unorganized hymenia (spores of young *Podaxis* are colorless).

Because of its axial, sterile columella, *Podaxis* suggests both *Secotium*²³ and *Endoptychum*,²³ but is closer to the latter because

²³ It is the opinion of C. W. Dodge, who has studied the type forms, that the Conard *Secotium agaricoides* is *Endoptychum* Czern. The latter genus has a powdery gleba, while Cunningham's *S. erythrocephalum* and *S. novaezealandiae* (12) have been shown by him to have gelatinous glebae which delequesce into slime; these species are only remotely related in their development to *E. agaricoides*. Dodge states: “*S. tenuipes* Setch. is a true *Secotium* of your flora.” Letter, May 26, 1931.

of its powdery gleba at maturity. It shows resemblance to Lycoperdaceae, particularly to the stalked puffballs, *Phellorinia*, *Batarraea*,²⁴ *Tulostoma*,²⁴ *Calostoma* Desv. (= *Mitremyces* Nees), and seemingly ends with Lycoperdaceae.

It has been the practice of taxonomists, e.g., Saccardo, Clements, Dodge, Lloyd, to associate *Podaxis*, *Secotium*, *Gyrophragmium* in a group, naming it Secotieae or Podaxineae. The origin of *Secotium agaricoides* as described by Conard (8) is related to that of *Agaricus campestris* and *A. Rodmani*; he regards *Secotium agaricoides* as "a primitive or arrested agaric"—perhaps a paedogenetic form which comes to maturity in the "button" stage. To quote from Conard, "*Secotium* is a morphological intermediate between the Agarics and Gasteromycetes" (8, 1912, p. 108). It has been demonstrated in this laboratory that the early stages of *Podaxis* have absolutely nothing in common with those of Conrad's *Secotium*. Twenty-five years earlier even, de Bary wrote: "It is plain that *Secotium* (i.e. *S. agaricoides*) arranged in one special group along with *Podaxon* is founded only on superficial resemblance and is not tenable, and that such arrangement must be broken up" (1, p. 319). It thus appears that *Podaxis* does not even approach *Secotium* of Conard (*Endoptychum*) or Cunningham at any point in its life history.

While no histological studies of *Gyrophragmium* have ever been made, it is the opinion of the writer that this genus along with *Endoptychum* will be found to constitute a transition between the two large groups, Gasteromycetes (Lycoperdales) and Hymenomycetes.

Podaxis, notwithstanding its strong external resemblance to *Coprinus comatus*, especially in the young stages, is out of place in the table presented by Underwood who shows *Podaxis* removed from *Agaricus* only by the two genera, *Coprinus* and *Montagnites* (43).

Phellorinia Berk. is the only well known affinity. The validity of *Chainoderma* Mass. is questioned. *Cauloglossum* Grev. does not enter into the discussion since it is a synonym of *Podaxis* based on the same *Podaxis pistillaris* and *P. carcinomalis*. *Rhacophyllus* Berk. may be found to bear a relationship to *Podaxis*.

²⁴ Spelling of the author Persoon.

In view of findings to date, *Podaxis*, together with any other plants²⁵ which shall be found to have a corresponding arrangement of fascicled basidia, also powdery glebae at maturity may constitute a tribe of Lycoperdaceae to be called Podaxineae.

SUMMARY

Podaxis is found within the fortieth parallels north and south of the equator approximately. Its altitudinal range extends from sixty-five feet below sea level to five thousand feet above. An examination of a large amount of material collected from the southwestern regions of the United States shows great macroscopic and microscopic variations. Spores vary notably in size and shape. The capillitial thread is spiral in structure; spirality may be observed occasionally in fairly mature material. Only one North American species of *Podaxis* is known.

An examination of Old World material shows precisely the same types of variation. Basidia, spores and capillitial threads in both Old and New World material show similar, progressive stages of development, conditioned by the age of the plant. Every specimen examined is therefore referable to one species, *Podaxis pistillaris* (L. ex Pers.) Fries. Species reduced to *P. pistillaris* are: *Lycoperdon carcinomale* L., *L. axatum* Bosc, *Podaxis senegalensis* Desv., *Mitremyces indicus* Spreng, *Podaxon calypiratus* Fries, *Podaxon loandensis* Welw. & Currey, *P. elatus* Welw. & Currey, *P. mossamadensis* Welw. & Currey, *P. Emerici* Berk., *Podaxis Farlowii* Mass., *Podaxon mexicanum* Ellis, *P. arabicus* Pat., *P. Deflersii* Pat., *P. Schweinfurthii* Pat., *P. squamosus* Pat., *P. Perraldieri* Pat., *P. Chevalieri* Pat., *P. algericus* Pat., *P. Glaziovii* Henn., *P. ghattasensis* Henn., *P. Gollani* Henn., *P. Mülleri*, *P. macrosporus* Speg., *P. termitophilus* Jumelle & Perrier, *P. anomolus* Lloyd.

Species probably to be reduced are: *Podaxon argentinus* Speg., *P. patagonicus* Speg., *P. Paoli* Berk. (?) (Canary Is.), *P. Ferlandi* Mott (Abyssinia).

The fascicled arrangement of basidia found in *Podaxis* and

²⁵ "I think it is quite likely that eventually we shall find a group with a more or less independent evolution, having this common mode of spore production" (fascicled basidia). Letter, C. W. Dodge, May 26, 1931. See also his *Alpova* paper (14, 1931).

Phellorinia, in place of a palisade or even irregular arrangement (Sclerodermataceae), is most unusual in Basidiomycetes. Such unorganized hymenia suggest a possible relationship with certain Ascomycetes, e.g., *Leucogaster*, *Alpova* (14) (47). *Podaxis* and *Phellorinia* seem to constitute a tribe of the family Lycoperdaceae. An association with *Secotium* as described by either Conard or Cunningham is not justified because of a lack of correspondence in their glebal tissues.

ACKNOWLEDGMENTS

The writer wishes to make grateful acknowledgment to Professor Lee Bonar and Doctor E. B. Copeland, Department of Botany, University of California, also to other members of this faculty who have given helpful suggestions from time to time; to the late Professor Roland Thaxter, Farlow Herbarium, Harvard University; to Professor C. W. Dodge, Washington University, and Mycologist, Missouri Botanical Garden, who has critically reviewed this paper as well as studied some of the material; to Doctor C. L. Shear and John A. Stevenson, United States Department of Agriculture, Washington, D. C.; to Miss E. M. Wakefield, Mycologist, Royal Botanic Gardens, Kew, England; also to Dr. Fred J. Seaver, The New York Botanical Garden; and to many other officials, and particularly to the numerous collectors who have made this work possible.

These studies have been made in the hope that interest in a long-observed and variously named group of plants may revive; that reports from localities not yet heard from may come in; that further data especially concerning relationships of *Podaxis* may be supplied.

UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA.

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²⁶ Desvaux had no part with either of these names

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EXPLANATION OF PLATES

Photographs and Photomicrographs by W. C. Matthews

PLATES 2-5 (FIGS. 1-7)

"SEVEN AGES" OF *PODAXIS*

Figs. 1, 1. Very young plants, root processes in place early differentiated into "foot" and head.

Fig. 2. Older, foot well developed, outer tissues split into ligulate scales.

Fig. 3. Still older, gleba (at first white) takes on a pale yellow-mahogany tone. Stipe, continuous through the peridium with narrow attachment at the summit, shows a central canal filled with a longitudinal web of floccose hyphae.

Fig. 4. Vertical section of an older plant with gleba more deeply colored. Columella—the elongated stipe—has become detached from the endoperidium. Indio, California (Smiley). *a, b*, *pl.* 3: Left and right-handed twists in the stipe. *c*: An unsymmetrical, "depauperate" plant, never reaching maturity (frequently met).

Fig. 5, *pl.* 2. Much older plant with "perfect foot," peridium broadest at the summit (rare) shows no indication of release from the stipe. Scales have taken on a mica-like gloss.

Fig. 6, *pl.* 4. Gleba entirely ripe, peridium ready to be shed, calyptra-like. Note hoof-shaped foot. Head was held down by a heavy clod of adobe. *a, b*: A limited delequescence appears in the walls of peridia and as a drip down the stipe. El Centro, California (Northrop). See also, *pl.* 2, *a*.

Fig. 7, *pl.* 5, *B*. Endoperidium entirely denuded of scales, well weathered and polished. From clay river bottom, Casa Grande Valley, Phoenix, Arizona (Edwards). Plants may have remained *in situ* for an indefinite period of time. The two small plants, from Battle Creek Meadows, northern latitudinal range—40°—California (Jepson).

Plate 5, *A*, 1, 1. *Podaxis pistillaris*, a "sport," in which the thick fibrous columella fails to reach the endoperidium by one cm. (see, also, plate 9; extremely rare). Otherwise, no distinction in structure. Scales in actively

growing plant often hang out loosely. 2: Columella attached by a narrow isthmus, gleba pale orange-yellow, outer tissues of stipe split horizontally. Indio, California (Smiley).

PLATE 6

Figs. 1, 2, 3, show great variation in stature and in proportions of peridia; fig. 3, the tallest of all American plants collected, 26 cm. (Northrop).

Figs. 4, 5, show stipes longer than heads; fig. 5, the "bullrush" (Massee), gleba intact, was more firmly attached to columella than to endoperidium. Fig. 2, of snowy whiteness, retains its whiteness when dried, from Palm Springs, California. See, also, plate 1, frontispiece (Clary). Note variations in thickness of stipes.

PLATES 7 AND 8

Figs. 1, 2, 3. Robust plants, "fungus spithameus" (a hand span) (Fries), stipes short in comparison with peridia. Peridium at first tightly closed (1), later loosened at margin and splits from below upward (2, 3). Stipe enlarged in region of juncture with peridial margin (1, 3).

Fig. 4: Cespitose, clusters up to nineteen in number, have been noted (Smiley, Clary). Scales becoming dingy are gradually dried and worn away by wind or rain. Foot often pronged (the slender elongations of prongs lost in collecting), heavy and solid, presents great variation in shape. Highway, Indio to Coachella, September 30, 1929 (Smiley).

Inset. Gregarious plants imbedded in soil, peridia resting at ground line, fourth sporophore just appearing. Palm Springs highway, California, June 19, 1931 (Clary). $\times \frac{1}{2}$.

PLATE 9

Photomicrograph, vertical section of very young plant in which the columella does not meet the peridium by one cm. Exoperidium broken up into loose ligulate scales. Endoperidium 3-4 mm. thick in growing plant, firm and rind-like. Columella of tough fibrous tissue, with central canal. Glebal chamber filled with soft white pulpy tissue, contains irregular labyrinthine chambers. Walls of chambers roughened by compacted fascicled clusters of basidia. $\times 8$.

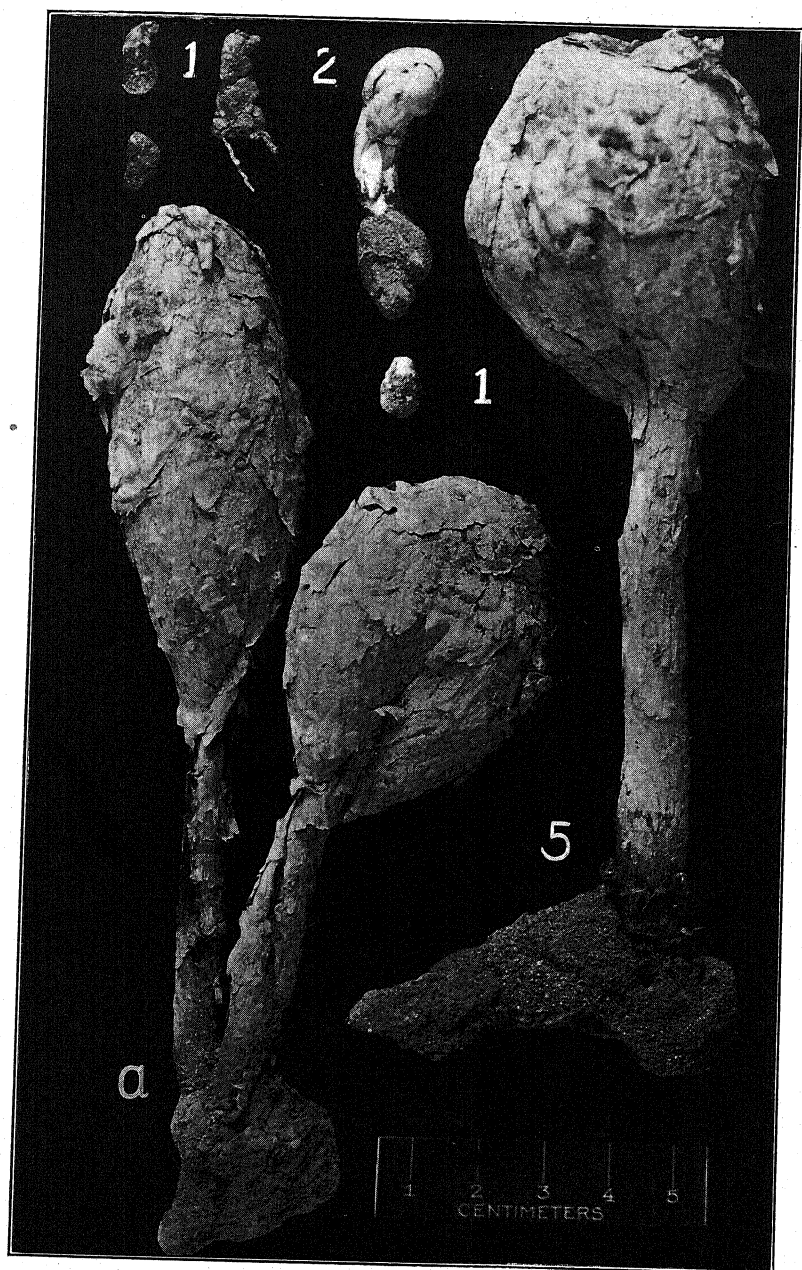
PLATES 10, 11, 12

Glebal tissues in Old and New World material compared.

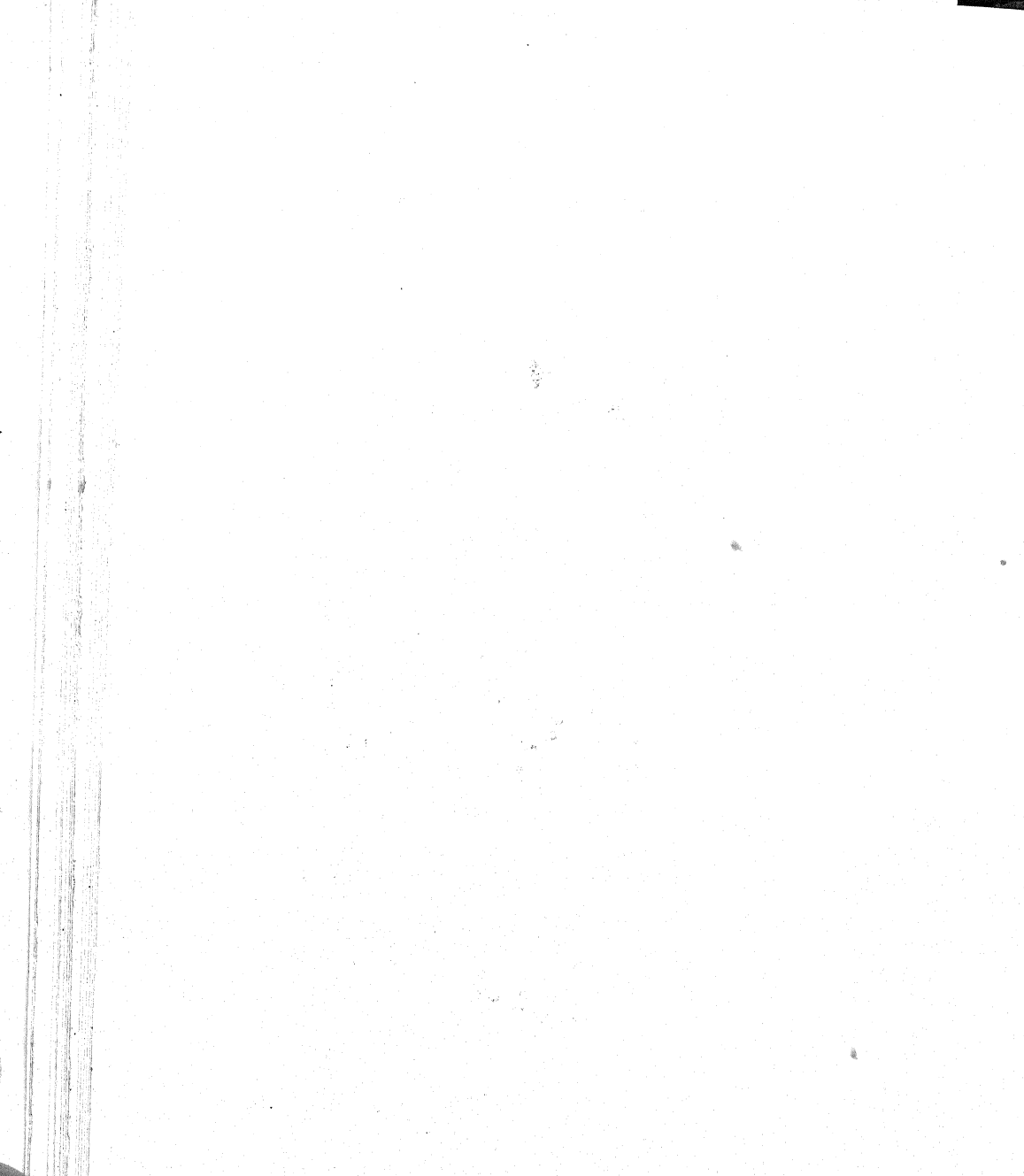
Plate 10, A. Spores in Colorado Desert material (Bridwell) show extraordinary variation in proportion and size. Note thick, double walls—the inner deeply colored a rich red-mahogany—also the protoplasmic content, and single germ pore which ends in a circular, hyaline disc by which light is transmitted. Some spores young, devoid of color. $\times 690$.

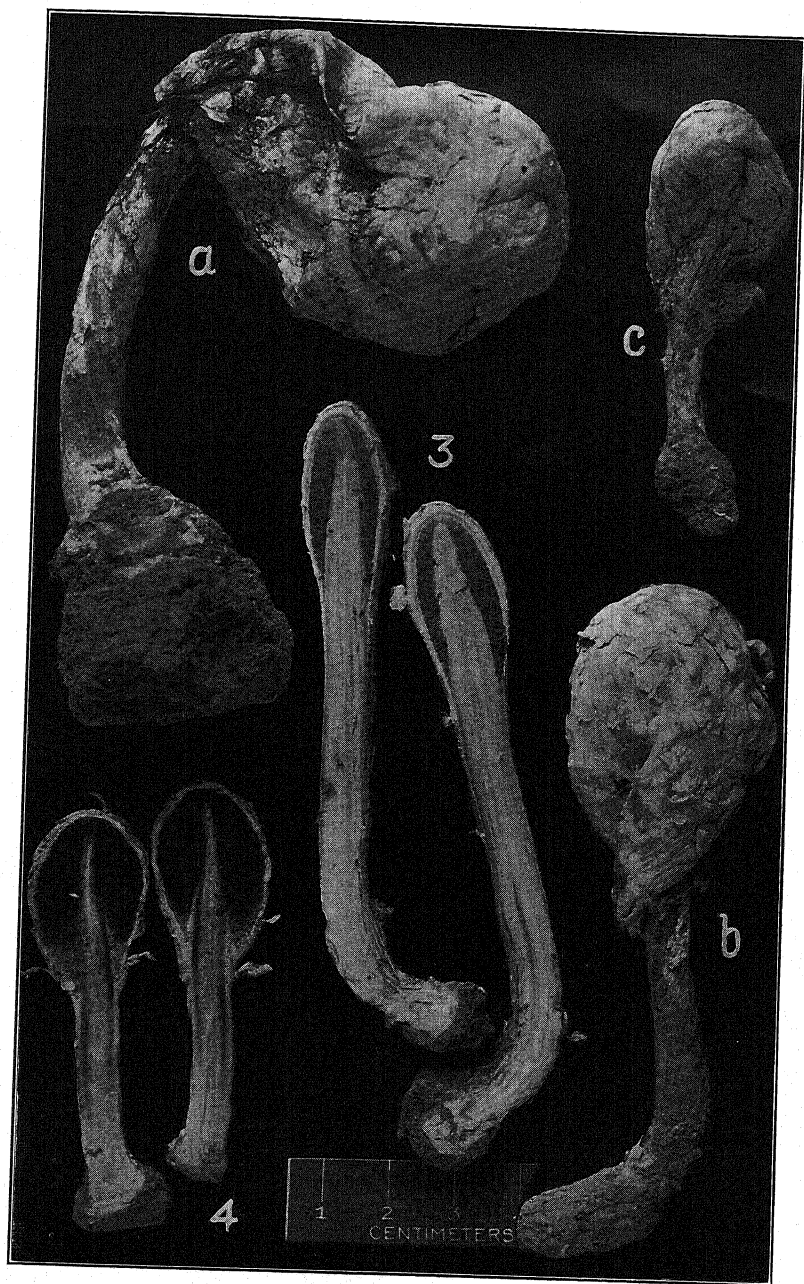
B. Fascicled, ovoid, hyaline cells—young basidia—large and small, issue from loosely woven ropes of compact hyphae. One large, distended basidium is loose from its cluster (in mount of 50 per cent lactic acid, very rarely seen). Note long, unbranched, colorless threads in this young material (Smiley). $\times 690$. See addendum.

Inset, fig. 1. An average spore in North American material, inclusive of Jamaica (from Thaxter), also of Hawaii (from Shear).

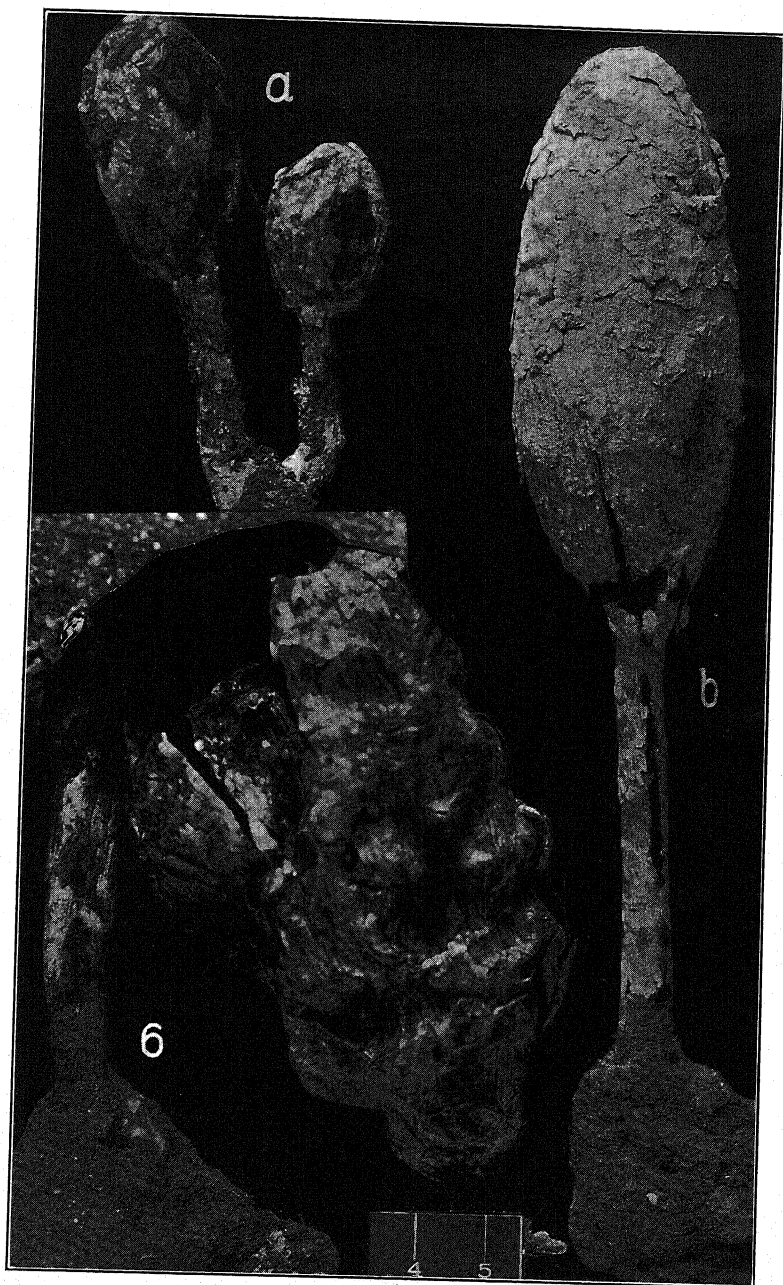


PODAXIS

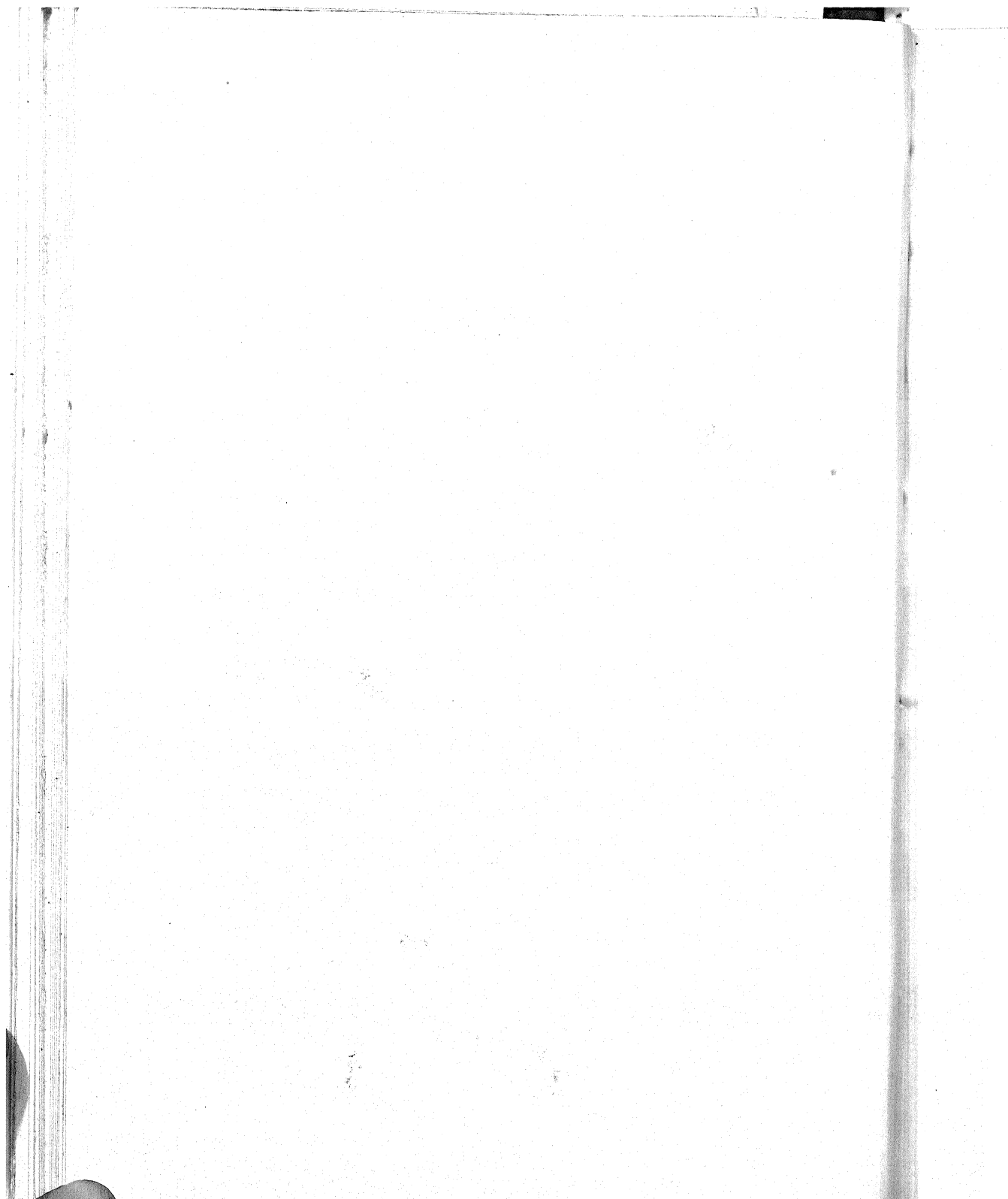


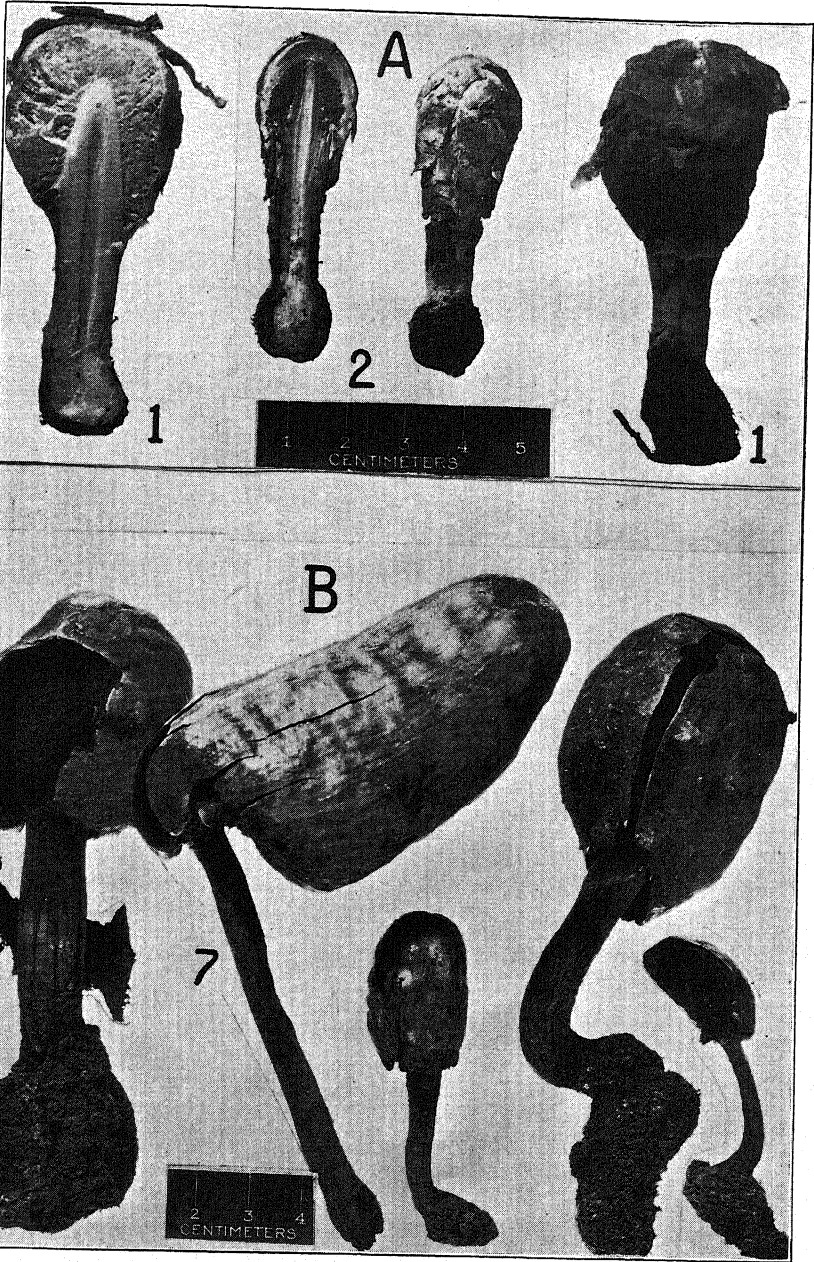


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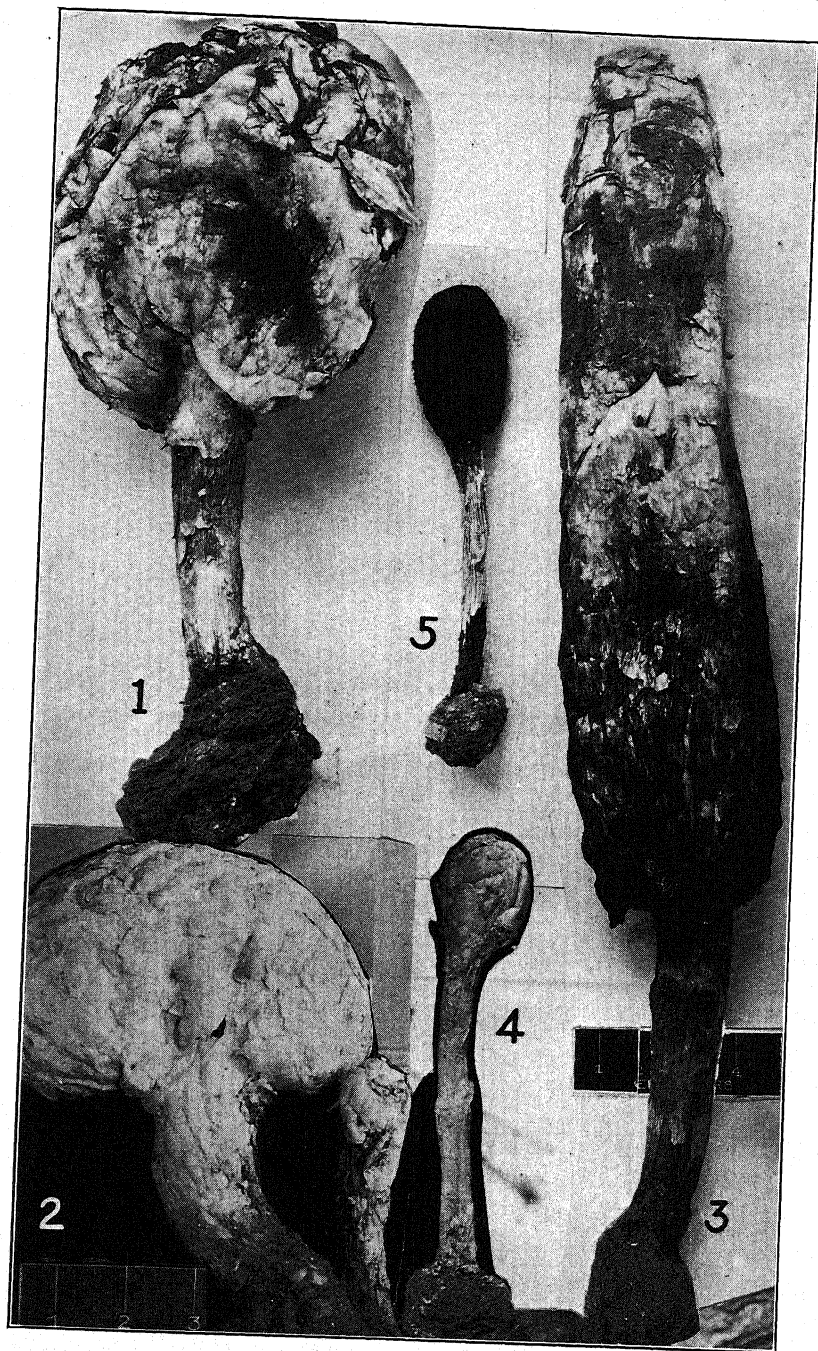


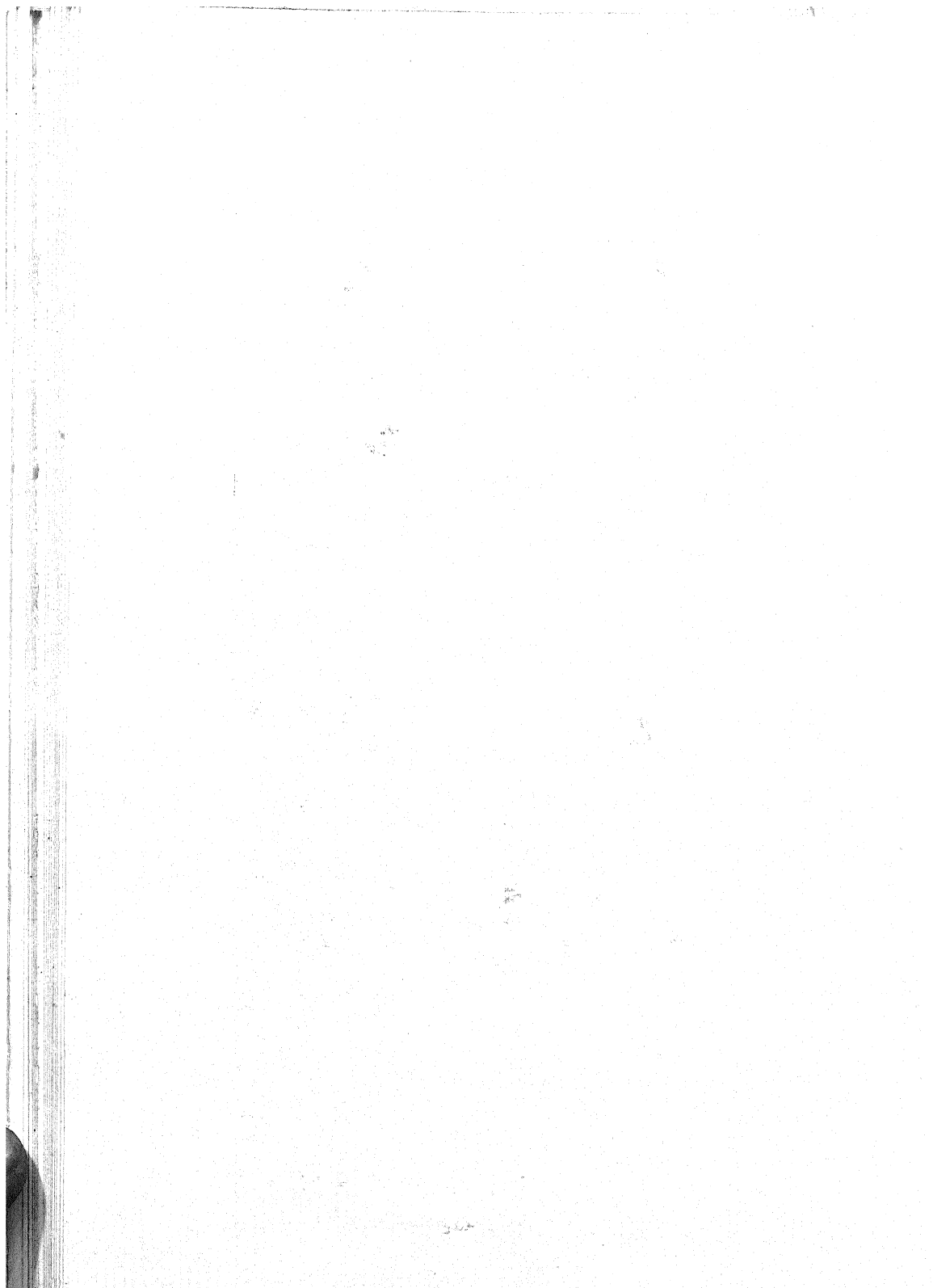
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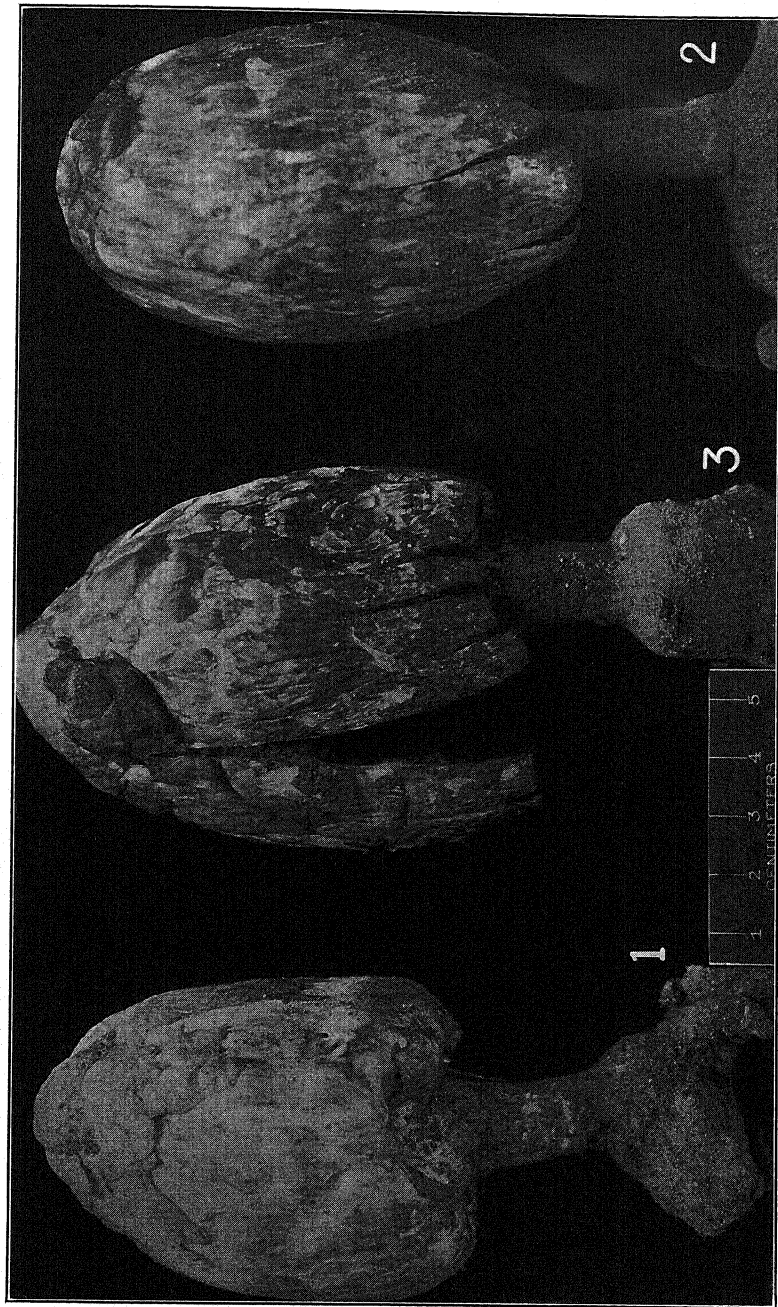




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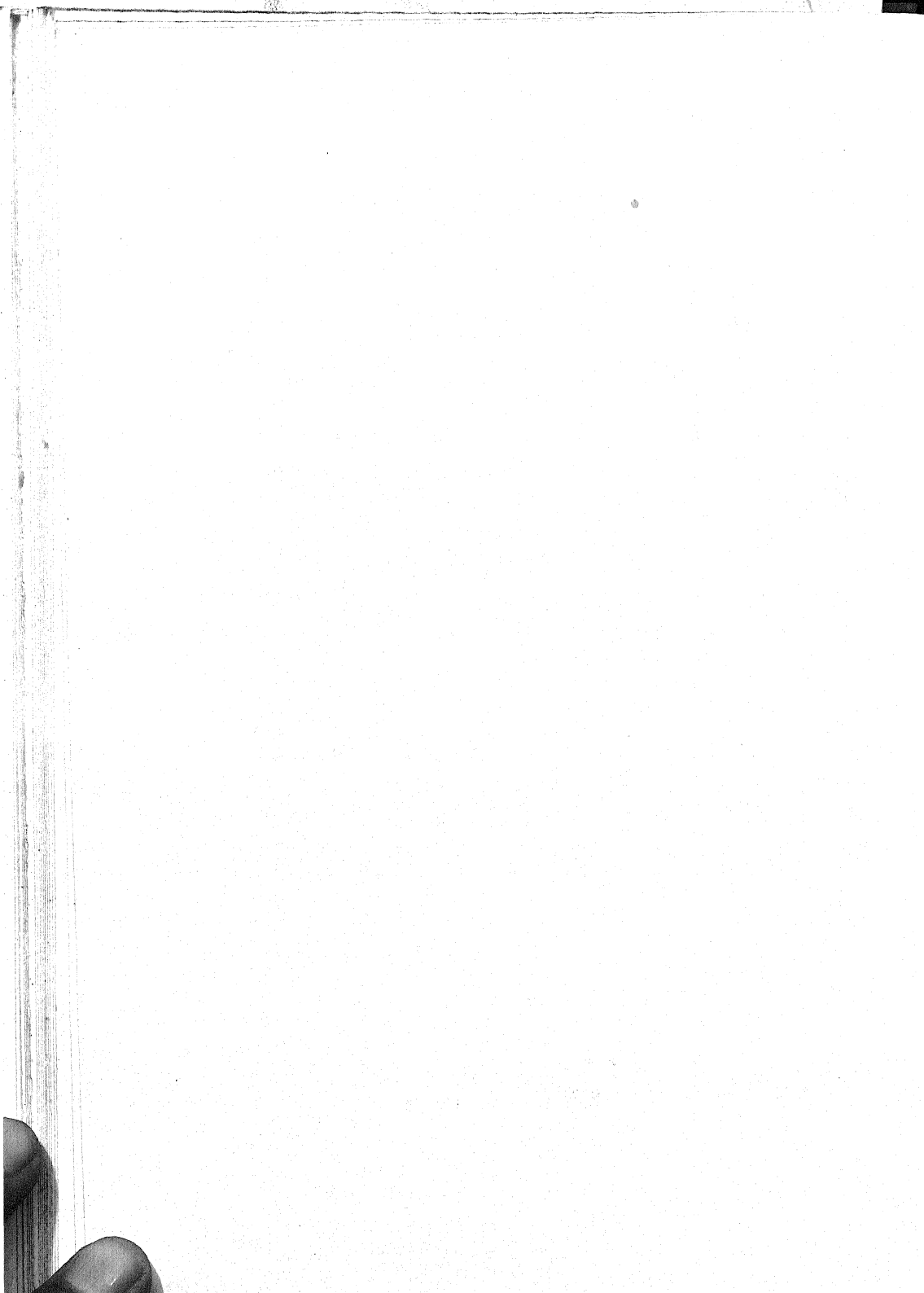




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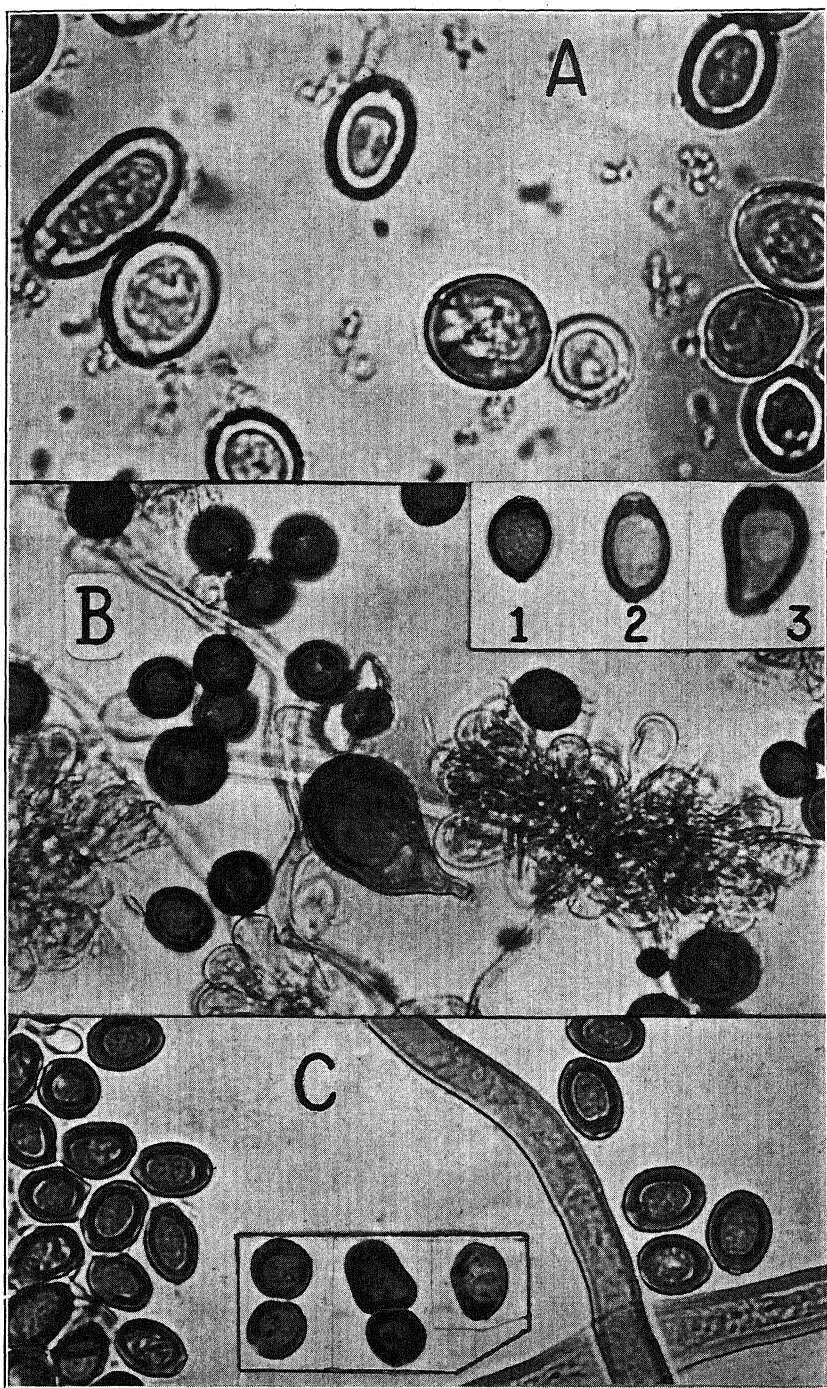


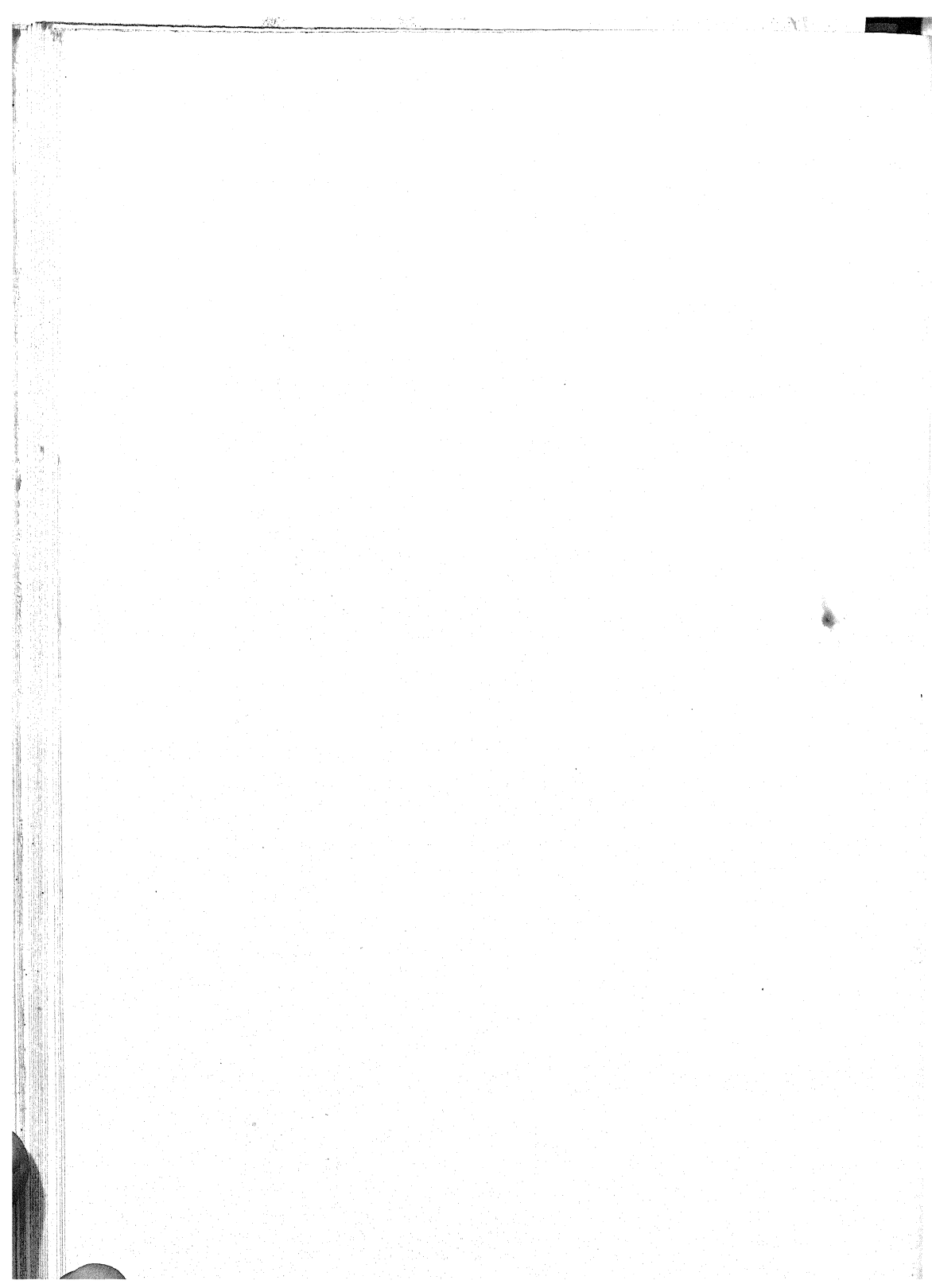
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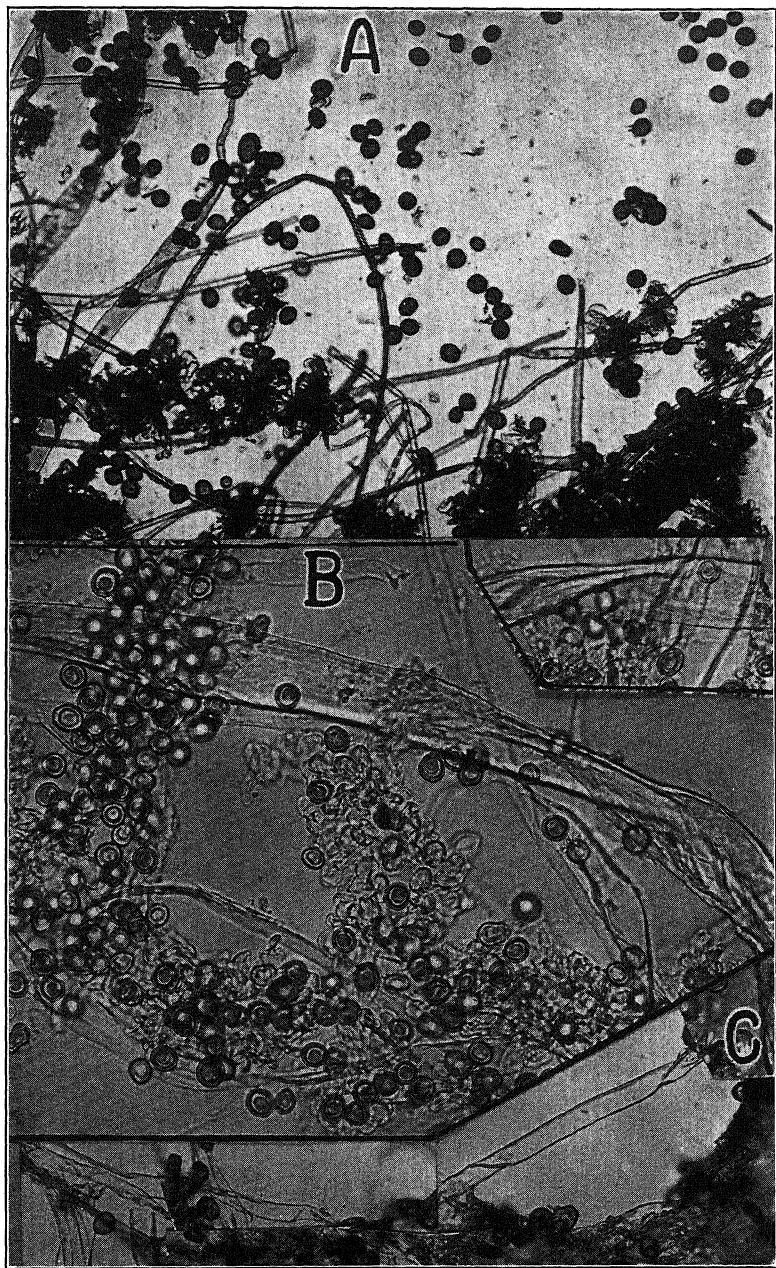




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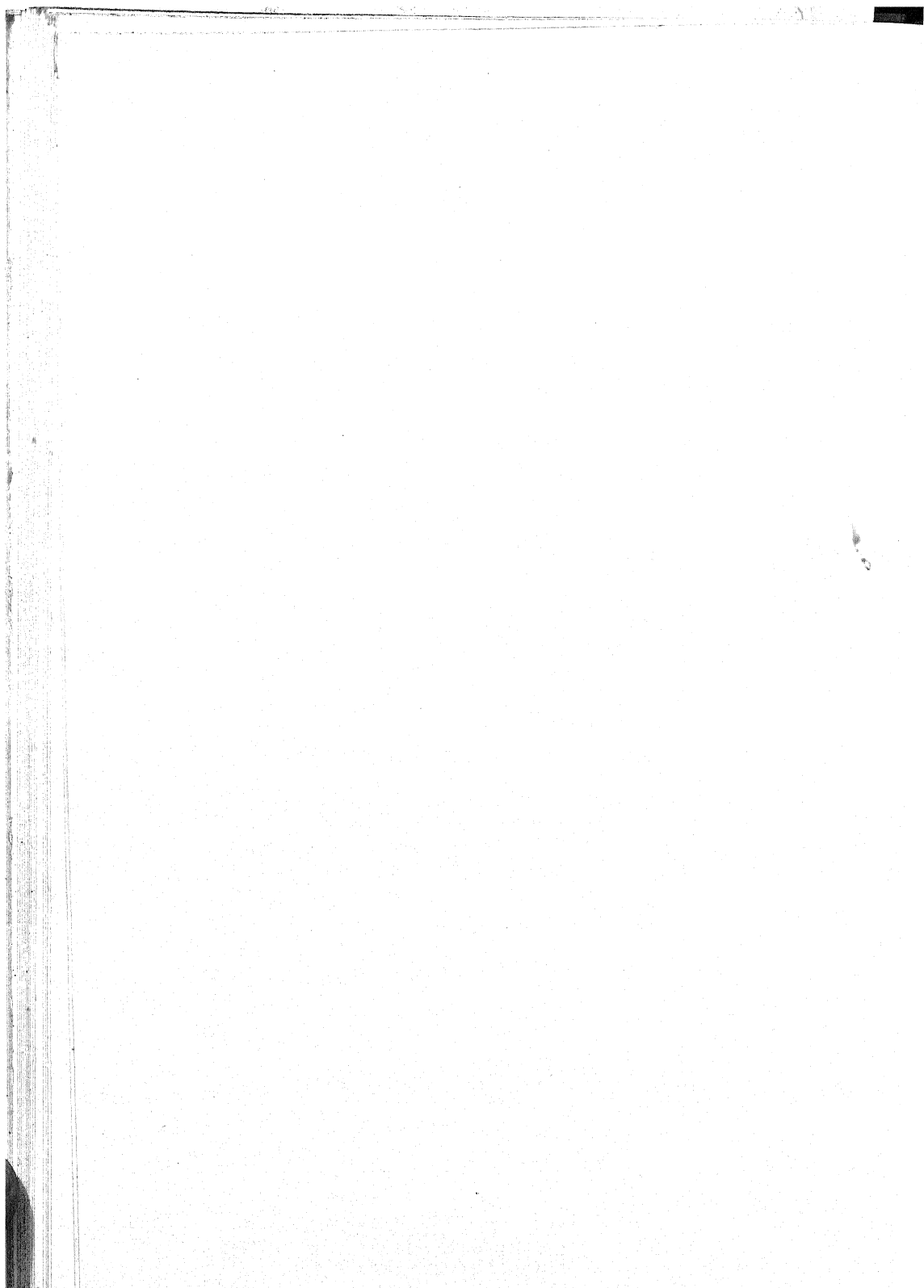


Fig. 2. An average spore in North, West and South Africa, inclusive of islands northwest of Africa (*P. squamosus* Pat.), also of Arabia, *P. arabicus* Pat. (from Maire). Spores show tendency to run broad. See plate 10, C, inset.

Fig. 3. An unsymmetrical spore; pear-shaped, constricted at center, or otherwise distorted, may be seen on any slide. See plate 11, A, B. $\times 690$.

C. Spores and capillitial threads from fully mature material, South Africa (Stephens). Note thick walls of thread, now deeply colored, also thick walls of spores, which show tendency to run narrow. $\times 690$.

Inset. *P. aegyptiacus* Mont. West Sahara (from Maire). $\times 690$.

Plate 11, A. Capillitial threads of varying widths, one blind end (rare) lower right. Spores vary in size and shape. Colorado Desert (Bridwell). $\times 170$.

B. One thread, broad, hyaline, flattened and ribbon-like, shows spiral markings and central canal (thread up to 24μ wide). Note other younger, narrower threads. Spores (borne on fascicled basidia), average broad, show variation in shape and coloration. Jamaica (from Thaxter). $\times 170$.

Inset. Extension of wide thread to the right with opposite twist.

C. Three spiral markings in thread (met "here and there" by Berkeley), from North Africa, *P. aegyptiacus* (from Maire). Spores resemble those in A and B in size and shape. $\times 170$.

Plate 12, A. A single, long, straight, hyaline thread—young—appears in the midst of a mass of fully mature threads. Note uninterrupted central canal. South Africa (from Wakefield). $\times 190$.

B. Capillitial threads fully mature, deeply colored, coil back on themselves rope-like. (All basidia and spores have disappeared.) Walls thick, rather rigid. One thread reveals its spiral structure by separating on lines of striae, showing an open spiral. Note spiral markings in other threads. South Africa (from Wakefield). $\times 212$.

C. Material from South Brazil (from Thaxter) shows precisely the same characters as observed in African material, A and B, except for the lack of an uncoiled thread. $\times 212$.

ADDENDUM

An illuminating article on the formation of spores in *Podaxis*, from the notes of R. Heim compiled by L. Mangin, comes to hand just as we go to press. It accounts for the extreme variation in size and shape of spores, and confirms the argument presented in this paper that species may not be set off on the basis of the types of variation just named. See *Compt. Rend. Acad. Paris* 194: 1182. 1932.

SEPTONEMA TORULOIDEUM: A STAGE OF MYTILIDION SCOLECOSPORUM¹

MARION LOHMAN

(WITH PLATE 13)

This paper presents a taxonomic and cultural study of *Mytilidion scolecosporum* Lohman (6), a species of the Hysteriaceae. The fungus² is an exceptionally interesting one, not only because it appears to be intermediary between *Lophium* and *Mytilidion*, showing in some aspects of its life history a rather close affinity with *M. Karstenii* Sacc., but also because it has as a conidial stage the seldom reported Hyphomycete, *Septonema toruloideum* Cooke & Ellis.

SEPTONEMA TORULOIDEUM

Unfortunately, Cooke and Ellis did not publish a complete record of the origin of their imperfect fungus which they described (Grevillea 7: 6. 1878) as *Septomena toruloideum*. There is, however, a specimen at the Farlow Herbarium labeled in the writing of Ellis, "*Septonema toruloidea* C. & E. On pine wood. Newfield, N. J. Oct. 17, 1877. J. B. E.," and it is undoubtedly from the original collection. Although it is much weathered, it shows all of the features which are of diagnostic value. There is no necessity of redescribing this material in detail but the following few corrections regarding the configuration of the conidial filaments and additions pertaining to the character of mature conidia, are worthy of record: *conidia deep fuscous throughout or with one or two of the apical cells paler, 3- to 5-septate, 14-18(24) × 4.5-5(6) μ, tapered apically and arranged in simple or sparingly branched, easily broken chains.*

In view of the variation in the size and septation of the conidia within a single member of the hyphomycetous genus, *Septonema*,

¹ Contribution No. 110 from the Laboratories of Cryptogamic Botany, Harvard University.

² Collected by Mr. A. H. Smith, from a much weathered stump of *Pinus Strobus* L., at Green Bay, Wisconsin, September 7, 1930.

the material from Wisconsin conforms surprisingly well to the original collection by Ellis. A few differences have been noted: (1) the measurements of the conidia reveal a slightly greater average length as compared with those given in the above emendation, the conidia (FIG. 4) measuring $18-22(25) \times 4.5-6 \mu$; (2) the average number of septa is slightly greater, the conidia being mostly 4- to 5-septate and in a small percentage 6-septate; (3) in the recent collection there has occurred a lesser degree of fragmentation, hence the branching of the filaments is more pronounced, and a greater number of the conidia show paler apical cells. But these are not serious discrepancies since the material, when collected, was in a far less weathered condition than was that collected by Ellis, and since, with the aging of the latter, undoubtedly the filaments have become further fragmented and the paler cells of the conidia have become more deeply colored.

When in a mature but unweathered condition, the filaments (FIG. 5) are erect or variously decumbent, sparingly branched, and measure 75 to 200 μ in length, depending upon the number and size of the conidia. Where the filaments are densely clustered, punctiform centers of sporulation 0.1 to 0.2 mm. in diameter obtain; otherwise, the areas of sporulation are irregularly effused. When in the best of condition, however, the conidial stage is noticeable to the unaided eye only as a blackening of the wood.

It is, presumably, the inconspicuousness of the areas of sporulation which is accountable for the fact that this imperfect stage, so elegant in its habit, has seldom been reported.

Of the few records, that by Ellis and Gerard (1, p. 566)³ and that by Peck (7, p. 117) are probably correct, for in each the substratum is the wood of *Pinus*, as it is in the original collection by Ellis and in the collection which initiated this study.

Septonema toruloideum Cooke & Ellis, then, is a taxonomically distinct hyphomycetous fructification occurring probably not infrequently on decaying wood of *Pinus*—and possibly of other coniferous species—in the northern and eastern regions of the United States, and, as the present cultural study indicates, it is to be sought in association with the perfect stage of the fungus.

³ Written "... *toruloides* C. & E." The name *S. toruloides* Berl. undoubtedly stands for another organism.

CULTURAL OBSERVATIONS

Since a *Septonema* (*S. spilomeum* Berk.) had been obtained in cultures of *Hysterium insidens* Schw., in an earlier investigation (5), it seemed highly probable that the occurrence of *S. toruloideum* about the hysterothecia of the then unnamed *Mytilidion* was more than a casual association. In verification of the supposed connection, cultural studies were made.

On November 18, 1931, two single asci with their contained germinating spores were isolated. When it was discovered that cultures developing on bacto-cornmeal and on Kauffman's synthetic agar medium (3, p. 144) were producing conidial filaments identical with those observed in the field material, additional isolations were made; a number of single germinating ascospores and single asci with intact germinating spores were obtained. Also, culturally produced conidia were sprayed upon plates of the synthetic agar medium and their germination was studied. The conidial development described below is based upon cultures which had originated from single ascospores in the second series of isolations, while the descriptions and figures of mature conidia are based upon the observation of the cultures of the first series.

It was observed in cultures which had originated in the second series of isolations, developing on the synthetic agar medium, that variously oriented, simple or sparingly branched filaments (50 to 100 μ in length) of from five to eight or ten light brown, swollen cells (4 to 6 μ in diameter) had developed by the fifteenth day from the long-celled hyphae of the surface layer. These short superficial hyphae, composed of a number of globular cells, actually chains of initial conidial cells, apparently develop by the successive budding of the distal cells. In their growth, branches arise by the lateral budding of the distal end of any initial conidial cell (but usually of only one or two) in the filament. It was further noted that these filaments of initial conidial cells are transformed into chains of conidia in a more or less regular basipetal manner by the acropetal development of each initial conidial cell. Hence, with respect to a mature conidium, the basal cell is the oldest and each succeeding cell to the distal end of the conidium has followed in order. Exceptions to the acropetal conidial development were observed but the mature conidia, by their shape, color of cells and

variation in the thickness of the wall, generally indicate this manner of growth. It was observed that in the maturation of any one conidium a lateral chain may arise by the lateral budding of any cell of the conidium.

Lateral chains which had arisen during the maturation of a conidium were usually short, being composed of from one to four conidia, while those which had been formed in the development of the filament of initial conidial cells, as already described, were long and conspicuous, maturing four to eight conidia, and more suggestive of the type of branching seen in the field material wherein most of the lateral chains had arisen from apical cells. In these lateral branches, as in the primary conidial chains, the terminal conidium ordinarily is first to mature and is usually the largest. Since a similar sequence in conidial development was found in the cultural study (5) of *Septonema spilomeum* Berk., I am inclined to believe that the successive development of conidia from the apex to the base of the filament is common to most of the species of *Septonema*, in spite of the fact that several forms, including *S. spilomeum*, have been illustrated with the larger and apparently older conidia in the basal portion of the filament.

Mature, culturally produced conidia (FIGS. 3, 6) were found to be identical in size, form, color and septation, with those of the field material. They are arranged in fragile chains which are supported by conidiophores, 20 to 50 μ in length, composed of a variable number of yellow to brownish cells, 2 to 3 μ in diameter (FIG. 6). The conidia germinate readily by a single cylindrical tube from each of the terminal cells (FIG. 3) and, occasionally, by a similar tube from any one of the central cells.

In the study of the germinating conidia it was noticed that the germ tubes of morphologically immature conidia ordinarily form first a series of short swollen cells in a manner which has been described and figured (4) for immature ascospores in certain species, and for apparently mature ascospores in other species, of the Hysteriaceae.

Although a pycnidial stage was found to be the usual type of secondary sporulation in the species of the Hysteriaceae which I had previously investigated (5), all efforts to induce the production of pycnidia in the cultures of this organism have been unsuc-

cessful. In its vegetative cultural characteristics the organism is scarcely distinguishable from a form which I have referred (5) to *Mytilidion laeviusculum* (Karst.) Sacc. It is only upon the production of the numerous conidial chains that the superficial layer in the cultures becomes more pronounced than that in the cultures of *M. laeviusculum*.

The cultivation of *M. scolecosporum*, then, from isolated germinating ascospores and isolated asci with their contained spores, has shown the associated hyphomycetous stage, identified as *Septonema toruloideum* Cooke & Ellis, to be a stage of that fungus. The cultural study has revealed the manner of conidial development, which is a rather complicated process, probably common to most of the species of *Septonema*, and one that has not previously been adequately described on the basis of growing material. The knowledge of the general mode of conidial production and the observation of exceptions to the rule, in culture, enable one to interpret more satisfactorily in the study of field material the various degrees of branching, the number of conidia in a chain and the number of septa in a conidium, all characteristics of taxonomic import, variations of which certainly obtain in the conidial sporulation of the organism under fluctuating field conditions. Particular attention has been given herein to this hyphomycetous stage because I am convinced that it will be through our knowledge of the imperfect stages that better specific and generic concepts in the Hysteriaceae will be achieved.

IDENTITY OF THE ASCIGEROUS STAGE

Mytilidion scolecosporum has been described in a previous paper (6). It is important, however, in inquiring into the probable affinities of the species that its diagnostic features be reviewed.

The dull black, longitudinally striate, aggregated fructifications are conchiform but not acutely keeled and measure 0.4–0.8(1) × 0.2–0.3 mm. They conform well to Karsten's (2, p. 245) original description of his *Lophium mytilinum* (Pers.) Fries. But, when compared with Karsten's distribution under that name and with the specimens of *Mytilidion rhenanum* Fuckel (956. Ex Herb. Fuckel. 1894) in the Farlow Herbarium they resemble more closely those under the latter name. They are in places sur-

rounded by the effused black crust of the *Septonema* stage. (Even Karsten noted (*l.c.*), "Perithecia plerumque e crusta late effusa. . . .")

The asci measure $100-130 \times 4-5.5 \mu$, being somewhat smaller than those originally described by Karsten (2, p. 245) for what is now known as *M. Karstenii* Sacc., and they are accompanied by delicate, septate paraphyses which are sparingly branched and interwoven above. The paraphyses resemble those commonly encountered in species of *Mytilidion* more than do the still more delicate sterile filaments seen in species of *Lophium*.

As to the spirally biserially arranged ascospores, they are elongated, subvermiform, occasionally bent or subsigmoid, 5- to 7-septate, yellow to clear brown, and measure $40-50 \times 2-2.5 \mu$. The ascospores are slightly longer and not as broad as those described by Karsten. They are figured here (FIGS. 1, 2) with those of Karsten's "Fung. Fenn. 93," in which the 3- to 4-septate spores measure $31-37 \times 3.5-4 \mu$, being smaller than the 3- to 7-septate spores described by Karsten (2, p. 245) as measuring $34-45 \times 4-5 \mu$. Although it was noted that the hysterothecia of the new form resembled closely those of *M. rhenanum* Fuckel, the 3- to 5-septate spores of the latter are still smaller, averaging $28-32 \times 3.5-4.5 \mu$, agreeing more or less with Rehm's conception of that species.

Rehm (9) retained both *M. Karstenii* Sacc. and *M. rhenanum* Fuckel, in spite of their intergradation. Previously (8), he had noted that the former is a species intermediate between *Lophium* and *Mytilidion*. As the comparative data related above indicate, *M. scolecosporum* shows a probable close relationship with these two species but stands apart in that the ascospores are both longer and narrower than those of *M. Karstenii* Sacc. There is to be considered, however, the evidence contributed by the conidial stage; evidence which indicates a possible close affinity of this scolecosporous form with *M. Karstenii*, thus supporting Rehm's (9) contention that in these forms we should not place too much emphasis on the character of the ascospore.

In 1886, Dr. Thaxter collected (at Kittery Point, Me.) a form on *Pinus* which he determined to be *M. Karstenii* Sacc. Its ascospores are yellowish to clear brown, 3- to 7-septate with slight

constrictions at several of the septa, tapered only slightly toward the upper end, and measure $38-49 \times 4-4.5 \mu$. The specimen in the Farlow Herbarium represents very well the fungus which Karsten adequately described (2, p. 245). I find a much weathered *Septonema* stage associated with the hysterothecia. In it the conidia are deep fuscous, 3- to 5-septate, and measure $18-30 \times 6-7 \mu$, not exceeding greatly the measurements given herein for *Septonema toruloideum*. Again on *Pinus* but unaccompanied by a conidial stage, Dr. Farlow (at Shelburne, N. H.) collected the fungus in 1891. From the two collections of *M. Karstenii* that were made in New England, *M. scolecosporum* differs primarily only in its narrower ascospores.

The evidence is convincing that we have in this country a fungus very similar to that described by Karsten as *Lophium mytilinum* (Pers.) Fries, now known in Europe in divergent forms as *Mytilidion Karstenii* Sacc. Also, that we have a species, probably closely related to *M. Karstenii*, which is apparently intermediary between *Lophium* and *Mytilidion* and which perhaps is continuing largely by means of its conidial sporulation.

Likewise, the evidence is convincing that cultural studies, supported by the observations on associated conidial stages, will be necessary to a correct interpretation of the affinities of certain American and European species which appear on the basis of our present taxonomic system to be intermediate between *Lophium* and *Mytilidion*.

SUMMARY

This paper presents a taxonomic study of *Septonema toruloideum* Cooke & Ellis and the cultural evidence which establishes this long-known but seldom reported Hyphomycete as a stage of the recently described hysteriaceous fungus, *Mytilidion scolecosporum* Lohman. The original description of *Septonema toruloideum* by Cooke and Ellis is corrected on the basis of an examination of authentic material and some new light is thrown on the relative value of diagnostic characters in the hyphomycetous stages referable to *Septonema*, by the observations on the mode of conidial development in the pure cultures of the hysteriaceous fungus.

The two types of lateral conidial chains, as determined by their time and place of origin, are described as well as the manner of development of the filaments of initial conidial cells, the formation of mature conidia from single initial cells, and the sequence in the maturation of these cells in the development of conidial chains. The processes are described in some detail in view of their bearing on the identification of species of *Septonema* and in view of the lack of developmental studies in the literature on members of this form genus.

Particular attention is given to the hyphomycetous stage because of the conviction that a better understanding of specific and generic relationships in the Hysteriaceae will be reached through a careful study and proper emphasis of their imperfect stages.

NATIONAL RESEARCH FELLOW,
LABORATORIES OF CRYPTOGRAMIC BOTANY,
HARVARD UNIVERSITY.

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EXPLANATION OF PLATE 13

As reduced, all drawings except those of the last two figures represent an approximate magnification of $1350\times$. The true magnification, as well as the actual measurements of the materials figured, are determinable from the absolute scales shown. The scale for fig. 3 also applies to fig. 4.

Fig. 1. Germinating ascospores of *Mytilidion scolecosporum*. The one spore, by its two inactive cells, shows clearly the degree of swelling.

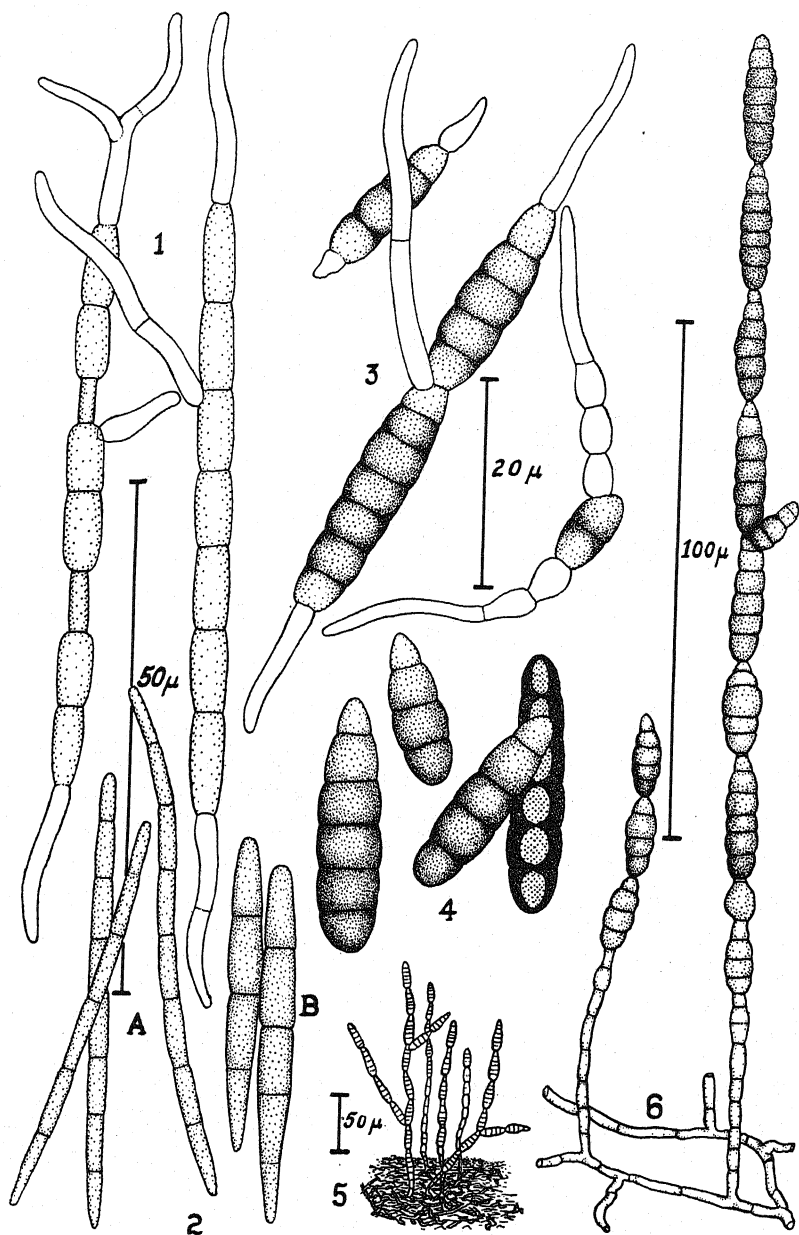
Fig. 2. *A.* Typical ascospores of this species as they appear when mounted in water and examined immediately. *B.* Two ascospores of *Mytilidion Karstenii* Sacc. as Karsten's specimen, "Fung. Fenn. 93," represents the species. The slightly longer spores described in the text for another American collection which also has a *Septonema* in association, are of the same general character but conform more closely to those upon which Karsten's original description was based.

Fig. 3. Conidia which were obtained in a pure culture of the fungus and then germinated upon a synthetic agar medium. The 4- to 6-celled conidia illustrated in this figure (and in the last) typify the mature conidia obtained in cultures which had originated in the germination of the ascospores of isolated asci.

Fig. 4. Mature conidia of the hyphomycetous stage which was associated with the perfect stage of the fungus and which proved to be *Septonema toruloideum* Cooke & Ellis.

Fig. 5. A habit sketch of several conidial filaments; based upon the associated imperfect stage and an authentic specimen of *S. toruloideum* Cooke & Ellis. The present magnification is approximately $137\times$.

Fig. 6. Two of the numerous conidial filaments which were observed in the pure cultures that had originated in the manner noted previously in the legend for fig. 3. In these cultures the degrees of branching illustrated in fig. 5 were again observed. Approximately, $\times 675$.



MYTILIDION

FURTHER STUDIES IN NEUROSPORA SITOPHILA

ALICE ARONESCU

(WITH PLATE 14)

It is known from Dodge's studies of *Neurospora* (1930) that if you cross an albinistic (non-conidial) strain of *N. sitophila* with a conidial strain you obtain perithecia with asci whose progeny present the conidial and the sex¹ characters as segregated in a perfect Mendelian ratio.

We shall discuss below our results in the study of this segregation in connection with the two opposite interpretations, that of Dodge (1931, 1932) on the one side, and that of Moreau and Moruzi (1931) on the other side, regarding the nature of the phenomenon which induces the formation of perithecia with asci.

SEGREGATION OF CONIDIAL FACTORS IN U-TUBE PERITHECIA

In a recent paper Dodge (1931) reports the results obtained in experiments concerning the formation of perithecia in U-tubes. Modifying the Moreau-Moruzi experiment he grows, in most of the cases, an orange-colored conidial race, for example, either 56.7 or 56.8 in one arm of the tube and an albino race, either 56.1 or 56.2 in the other arm. We shall not give here in detail the results and their interpretation, but shall merely mention that after careful observations regarding the growth of the mycelium in the two arms of the tube as well as regarding the place and conditions necessary for the formation of mature perithecia, the author concludes that "hypothetical diffusible hormones, if any are produced by the strains of *Neurospora sitophila* and *N. tetrasperma* cultured, are not potent to induce the formation of perithecia with asci in U-tube cultures such as were described by Moreau and Moruzi."

For the purpose of verifying in another manner the value of

¹ The term sex is used for convenience to indicate that two mycelia which must be grown together to produce perithecia behave as though they were of opposite sex.

this "hormone theory," we undertook to analyze the asci from the perithecia obtained by Dodge in some of his U-tube experiments.

In the analysis of the spores of these asci we could expect the following three alternatives:

1. We may suppose with Dodge that for the maturing of a perithecium an act of fertilization is necessary, that is, there must be a fusion of nuclei derived from hyphae of the two strains. In that case, whether the perithecia are obtained from the arm of the tube with $+C$ strain, or from that with $-C$ strain, we should find in all the analyzed asci, a segregation of sex and conidial factors in a perfect Mendelian ratio.

2. Corresponding to the conclusions of Moreau and Moruzi, namely, that there is at the basis of fertile perithecia no act of copulation and therefore no exchange of nuclei, but that it is all the result of the action of diffusible hormones, we should then find, if the perithecia were found in the arm with the $+C$ strain, that all the spores from any of the asci would give conidial strains with the same "sex" as strain $+C$. If, on the other hand, the perithecia are formed in the arm with the $-C$ strain, all the eight spores from every one of the asci must give albinistic strains like the $-C$ strain.

3. Let us consider a third possibility as suggested by Dodge (1931), namely, that contrary to all our present conceptions, the genes for the Mendelian inheritance of morphological characters are also diffusible hormones. We would then expect to find, as long as we know that there is no linkage between the sex and conidial factors (Dodge 1929, 1930) that the genes of these characteristics also should work separately and at random. In the analyzed perithecia we should then find, also at random, three categories of asci. In an arm where at the beginning we had, for example, a $+C$, "sex" B strain, we might find all eight spores $+C$, four sex A and four sex B; or we might find all eight spores of the same "sex," four $+C$ and four $-C$; or in the third case a Mendelian segregation according to the first alternative given above. Presupposing that the perithecia are formed in a $-C$ and "sex" B arm, there would still be, correspondingly, three other possibilities.

MATERIAL AND METHOD

The chosen material was as we have already mentioned, mainly from asci obtained by Dodge (1931) in his U-tube experiments. Aside from these cultures there were also analyzed other perithecia produced from inoculations made by the writer on corn meal agar U-tubes which served in the studies concerning the second question presented in this paper, the description of which is given in that part.

From Dodge's material we analyzed at random thirty-seven asci representing nineteen perithecia from eight U-tubes, and from our own material thirteen asci developed in six perithecia from five U-tubes.

For the germination of the spores and the derivation of strains we used the methods as described by Dodge (1928, 1930).

In this connection we should mention that the spores of some of the cultures kept in the ice box for some time for the purpose of checking the shooting of the ascospores, germinated with great difficulty and in a much lower percentage than those subjected to the usual conditions.

As a matter of fact the number of analyzed asci was much greater than fifty. We, however, took into consideration for this report, only the results from the asci which had at least five germinated spores, so that one of them could be different from the others, had any segregation taken place. In the case of three asci, where only four and three spores respectively germinated, the results were taken into consideration in as much as the germinated spores were of two kinds as to their factors for conidia.

The spores of twenty-five asci were separated in order so that the position of each spore in the ascus was known. Those of each of the other twenty-five asci were isolated without any order as to the position in the ascus. From among the first group we obtained five complete sets of eight germinated spores. From five other asci, cultures from seven spores each were obtained. From the remainder except for two asci with four and three germinated spores respectively, cultures from either six or five spores were obtained. From the asci the spores of which were isolated at random, we obtained, in eight cases, entire sets of eight germinated

spores, several sets with seven and six spores, a few with five each and one single case with four spores.

In all fifty asci, without a single exception, whether the spores were isolated in order or not, we observed segregation of sex and conidial characters in a perfect Mendelian ratio. Since a conidial strain, + C, was always grown in one arm of the U-tube and a non-conidial strain, — C, in the other, and both of these contrasted characters showed in each ascus, nuclei from each strain must have in some way come together in each ascus.

Wilcox (1928) found the sex factors segregating at the second division in the ascus. Subsequently it was determined that sex factors and conidial factors segregate independently (Dodge, 1929, 1930; Lindegren 1932) either at the first or the second division. Among the group of asci whose spores were isolated in order, "sex" factors were segregated at the first division in thirteen cases, and at the second division in the other twelve cases. The conidial factors were segregated at the first division in twenty-one cases and at the second division in only four cases.

We also found eleven cases where both sets of factors segregated at the first division and only two cases in which both sets of factors segregated at the second division.

The perfect segregation obtained with all the described cases, leads us naturally to the conclusion that the hormone theory of heterothallism in *Neurospora* announced by Moreau and Moruzi, has not been borne out in our experiments.

RATE OF MYCELIAL GROWTH AS RELATED TO SEX AND CONIDIAL CHARACTERS

In the studies concerning segregation of sex and conidial factors in *Neurospora*, previous authors have shown that there is no linkage between those two characters.

Lindegren (1932) in his paper on inheritance of response to heat treatment in *Neurospora* finds that in the case of *N. tetrasperma* the spores seem to respond in a rather uniform manner to heat treatment. He also finds that the small variations presented by *N. crassa*, after one hour of heat treatment, are possibly due to genetic factors. In the case of *N. sitophila* and of a certain hybrid, he finds two kinds of ascospores in respect to their response to heat

treatment. Due to the many variabilities observed, the author is in doubt as to whether this character could be considered in the genetics of *Neurospora*. He also does not find any obvious connection between this character and the sex and conidial characters.

Along the same line of thought the question arises as to whether another physiological character, namely "rate of growth," could not be constant and be represented by factors which segregate like the sex and the conidial factors, being possibly linked to one of these.

In a recent paper Moreau and Moruzi (1931) find a difference in rate of growth between the two mycelia of their conidial races of *Neurospora*. One is of French origin and "sex" B and the other one of American origin and "sex" A. They found that the "sex" B strain grew the more rapidly.

METHOD OF PROCEDURE

Two strains of different sexes were grown in one arm of a cornmeal agar U-tube; the medium in the other arm was not inoculated. The grouping of the pairs was made in such a way as to obtain all the possible fertile combinations among the strains derived from the same ascus. In this manner three different categories of crossings were possible, between — C and + C, between two + C strains and between two — C strains. It is evident that only one fertile combination could be made among those strains from ascospores formed in an ascus where segregation of conidial and sex factors took place at the first division.

It was made certain that the cultures used in the experiment were not old and that they were of about the same age. In all, eighty-six U-tube crossings were made.

At first, the surface of the agar in the arms of the U-tube was inclined. Afterwards it was changed to level, and was so maintained during the remaining series of experiments. The cultures were kept in an incubator at a temperature of about 25° C.

After an interval of from three to five days, perithecia were formed at the surface of the inoculated agar, while after six to ten days after inoculation, one of the mycelia of the two strains appeared at the surface of the agar in the second arm. This variation in time was due to the difference in lengths of the columns of

agar through which the mycelia traveled. The position of the growing mycelium in the agar could be observed and marked every day with the aid of a magnifying glass.

As soon as the first mycelial hyphae appeared at the surface of the second arm, transfers were made to a separate test tube. They were allowed to develop and the strain was finally tested for sex, being grown separately with each of the two strains from the first arm or with each of two albinistic strains, 56.6 "sex" A, and 56.1, "sex" B, used as tester strains. Having found in this manner the sex of the strain which arrived at the surface of the second arm, it was definitely established which of the two strains inoculated in the first arm grew the faster. For the purpose of eliminating any uncertainty it must be mentioned that as soon as one of the strains begins to grow downwards, toward the connection arm of the U-tube, the growth of the second strain is entirely checked.

Each series of U-tubes was very carefully observed through a period of one month. In not a single case did any perithecia form at the surface of the second arm. This means that in no case were both strains able to arrive at the surface of the agar in the second arm.

After varying intervals of time the agar in the two lateral arms of the U-tube began to dry, and air pockets appeared against the glass. In most cases the first pocket formed was that in the arm where the two strains had been inoculated. Even though the two mycelia were later found in this first air pocket, nevertheless, there was rarely found examples in which they formed perithecia in this region. It is probable that most times and especially when a greater interval of time had passed until pockets began to form, the mycelium which had grown more quickly towards the surface of the agar of the second arm of the U-tube was too old to take part in fructification.

Most frequently, after the appearance of one of the strains at the surface of the agar in the second arm, air pockets began to form there as well. During this time branches from the mycelium which had arrived at the surface had grown backwards along the column of air and as soon as the two pockets joined in the connecting arm, the two mycelia met. In the usual interval of time perithecia were formed in this space, beginning in the con-

necting arm and continuing for some distance along the arm of the tube where inoculations had been made.

We should add that of the eighty-six tubes experimented with, one whole series of eleven which were poured and inoculated on the same day, behaved, at the beginning, differently from all the others. In all these cases the growth of the mycelia was checked almost immediately after the formation of the perithecia. These tubes were kept under observation from February 9 to March 28 during which time one could easily see, by the aid of a magnifying glass, that the mycelia remained completely stationary. On March 28th, with the aid of a sterile probe, the agar column was separated all around from the glass as far down as the length of the probe allowed it. Air pockets could then be seen against the tube walls and after from four to eight days, one of the two strains in every one of the tubes appeared, as usual, at the surface of the agar in the second arm.

The importance of the presence of air in the formation of perithecia and the growth of the mycelium through the agar is shown by Dodge in a recent paper (1931), and Dr. F. L. Denny of the Boyce Thompson Institute has recently reported before the Torrey Botanical Club (*Torrey* 32: 138. 1932) further important contributions on oxygen requirements.

RESULTS OBTAINED

In our observation, the aim was to find, as already mentioned above, whether there is a linkage between factors for "rate of growth" and factors for conidia or for sex. The results show that no linkage can be established between those characters. It is quite apparent that the preponderance of growth of one of the strains depends upon no set rule and that it is probably very largely determined by the conditions in the medium. See plate 14.

It was at first thought that the inclined surface of the agar might give rise to errors in the interpretation of the results for the reason that the conditions for the growth of the two strains were not equal. The same inoculations repeated on level surfaces did not make any difference in results. The same pair of strains, crossed several times in different series of experiments, behaved differently. Even if it may have appeared at times that one of the

strains of the pair had a more rapid rate of growth, nevertheless the variations noted from all the results were so numerous, that it was necessary to conclude that the "rate of growth" is not a characteristic linked either with sex or with conidial factors. Two strains of different sexes, on the one hand, or an albinistic and a conidial strain on the other, do not seem to be constantly different as regards "rate of growth." Still, we cannot overlook the question as to whether "rate of growth," without being linked to the other characteristics, may not be a fixed character represented by genes which could segregate independently. Our experiments do not tell enough in this connection. Other conditions are required in which all the strains from an ascus should be cultivated comparatively in separate U-tubes under identical conditions and through several generations.

SEGREGATION OF "SCLEROTIUM" FACTORS IN ALBINISTIC
STRAINS OF *NEUROSPORA SITOPHILA*

The presence of sclerotia, bulbils or incipient perithecia in cultures of *Monilia sitophila* is mentioned by several authors (Dodge 1930, 1931; Moruzi 1930).

During our experiments, mentioned above, concerning segregation in U-tube perithecia, while analyzing the asci formed by mating two albinistic strains, we found in two successive cases two complete sets in which four of the albinistic strains showed a great abundance of incipient perithecia ("sclerotia"), while the other four had very few of these bodies. The great difference between the number of bodies was very evident. The four strains rich in these structures have a grayish-black appearance, while those with the very few, still show frequently the yellow color in the tufts of the aerial hyphae.

For the purpose of facilitating the explanation of what is to follow, we shall designate the strains with few incipient perithecia by "s" and those strains with large number by "S."

After having determined the sex of each of the cultures, crossings were made between strains of opposite sex, one being "s" and the other "S." Complete sets of spores from two asci were isolated and grown. These were second generation and showed again the characteristics "s" and "S" separated in the same

manner and perfectly distinct. Tried again for sex on a different lot of corn-meal agar medium it was noted that the sex factors segregated independently without any relation to the sclerotial condition.

By making transfers of these strains of the second generation still on corn meal agar, the differentiation did not manifest. The same transfers were then made to potato-dextrose agar with $\text{pH} = 5.6$ and dextrose agar with $\text{pH} = 7.5$. The differentiation appeared again very definitely. The fact that this character did not behave uniformly in all the transfers, might be due to one of two alternatives; either this is a character that is not constant or, if it is, it does not appear with every cultural condition, because it might be influenced by the composition of the medium and by its pH. New experiments were carried out to obtain further information on this question.

METHODS

We should mention here that in the two sets of strains, regarding which we spoke above and which we continued using in our experiments, the cultures were marked in the following manner:

In one of these, the spores were numbered from 1 to 8 being isolated in the order showing their position in the ascus. In the second set the cultures were distinguished by letters a to h, the spores being isolated at random from that ascus. In the first set the strains 1 to 4 were those with numerous incipient perithecia, "sclerotia" ("S"); while numbers 5 to 8 had few "sclerotia" ("s"). From the second set, strains a, e, f, d, were "S" and b, h, g, c, were "s."

Both series of cultures were transferred to four kinds of media which were in turn changed to four different pH values, approximately 5.4, 6.4, 7.4 and 8.4. Two identical series of experiments were run at different times.

We give below the media with their respective formulas.

CORN MEAL AGAR. Extract from 40.1 gr. corn meal at $60^{\circ}\text{C}.$, for 1000 cc. of medium.

DIFCO POTATO DEXTROSE AGAR. (A preparation containing infusion from dried potatoes, bacto dextrose, bacto agar.) 40 gr. for 1000 cc.

DIFCO BACTO DEXTROSE AGAR. (Containing bacto beef extract, bacto peptone, bacto dextrose, bacto agar.) 33 gr. for 1000 cc.

CZAPEK'S SOLUTION AGAR. (After Thom; 2.0 gr. sodium nitrate, 1.0 gr. potassium phosphate, 0.5 gr. magnesium sulphate, 0.5 potassium chloride, 0.01 gr. ferrous sulphate, 30 gr. sucrose. 1000 cc. distilled water.)

The entire lot of medium necessary for one series of experiments was made at the same time. The pH was afterwards changed by adding, according to need, HCl or NaOH in N/10 solutions. The pH was checked, for the acid media, with the aid of indicators bromocresol purple and chlorophenol red in solutions of 0.04 per cent, and with phenol red and cresol red 0.02 per cent for the alkaline media. For comparisons we used the chart of indicators from the 3d edition of W. M. Clark's manual "The Determination of Hydrogen Ions." It is apparent that the method used permits but rough comparisons. We may pass over, however, the possible experimental errors involved, considering them as relatively unimportant as regards the results obtained in the growth of the fungus.

RESULTS OBTAINED

On corn meal agar the segregation appeared very distinct. The strains "S" had a dark gray color with innumerable "sclerotia" giving the medium a blackish appearance. Strains "s" presented light pink tufts of mycelium and very few "sclerotia" were visible to the naked eye. These contrasted differences were relatively the same in all of the cultures, irrespective of the pH of this medium, showing that the pH factor, so far as varied in this experiment, does not bring about any change in their general aspect.

On potato dextrose agar the segregation also appeared, but not as definite as on corn meal agar. An abundant mycelium was present in all the strains. The "S" cultures had again the large number of "sclerotia" but giving the medium a brown-blackish appearance. The "s" strains had fewer of these bodies turning the medium to a dark reddish-brown color. The variations in the pH gave rise here to small differences, the color shades of the media became lighter with the increase in acidity.

On Czapek's solution agar the difference was again very ap-

parent. Strains "S" presented numerous "sclerotia" and quite abundant mycelium. Cultures "s" did not have any of those bodies as far as could be seen with the naked eye, while the mycelium was poorly developed. There were no perceptible differences brought out by the changes in pH.

On the dextrose agar, irrespective of the pH, the mycelium of all the strains is very abundantly developed, presenting at the upper part of the culture rich tufts of yellowish color. Very few perithecial bodies appeared, therefore the segregation was not visible.

These results may be interpreted as follows:

Recent studies (Dodge, 1932) have confirmed the opinion that these organs are incipient perithecia. By spermatizing these incipient organs of a strain of one "sex" with monilioid conidia or with microconidia from a strain of the opposite "sex" mature perithecia with ascospores were obtained.

Having this in view, we are able to explain why the segregation of the factors for this character continues to be incomplete during two generations. As long as we assume that these organs are incipient perithecia, we cannot ever expect a complete segregation, unless the production and the function of these receptive bodies is controlled by several pairs of factors or is an indication of femaleness.

The constant character obtained by us should be then interpreted in the sense that some strains are capable of greater fructification and form, therefore, more incipient perithecia, while others are less fruitful and form fewer receptive bodies.

SUMMARY

1. Our experiments lead to the conclusion that the theory proposed by Moreau and Moruzzi concerning hormone responsibility in the formation of mature perithecia in *Neurospora sitophila*, is untenable.

2. Rate of mycelial growth in *N. sitophila* is not linked to sex or conidial characters and seems to be greatly influenced by environmental conditions. This is not to deny that certain strains may not have an inherently high rate of growth or vice versa.

3. In a mating of albinistic strains of *N. sitophila*, we observed

in the same ascus the separation in an uniform and constant manner of characters "S" and "s."

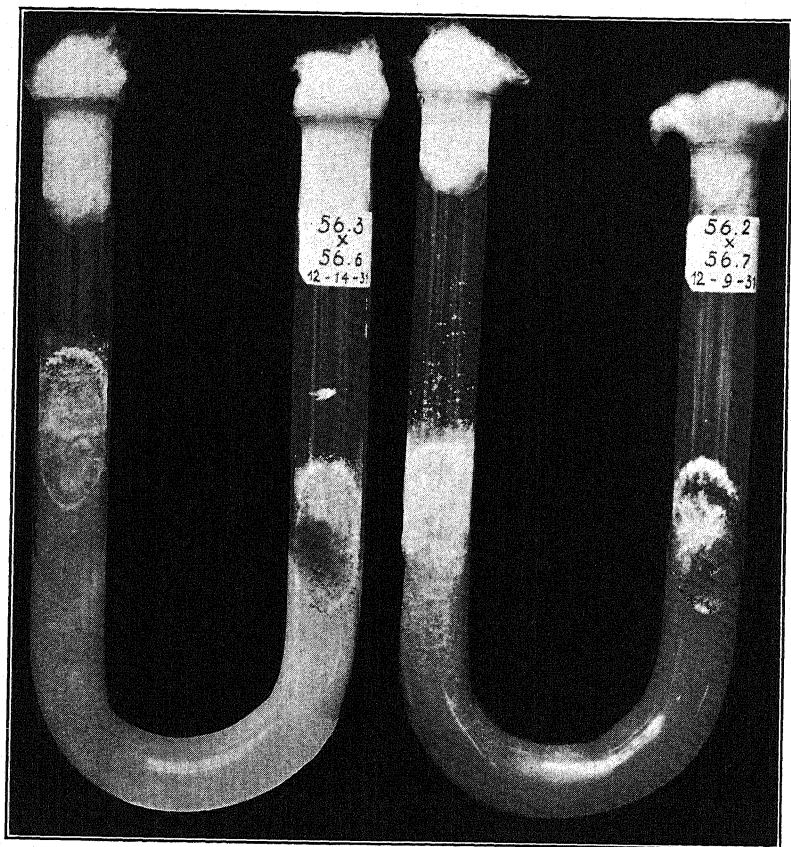
The incomplete segregation obtained, strengthens the assumption that these organs are incipient perithecia.

4. It is obvious that the appearance of "sclerotia" or incipient perithecia depends on the composition of the nutrient medium, but is not much influenced by the pH factor.

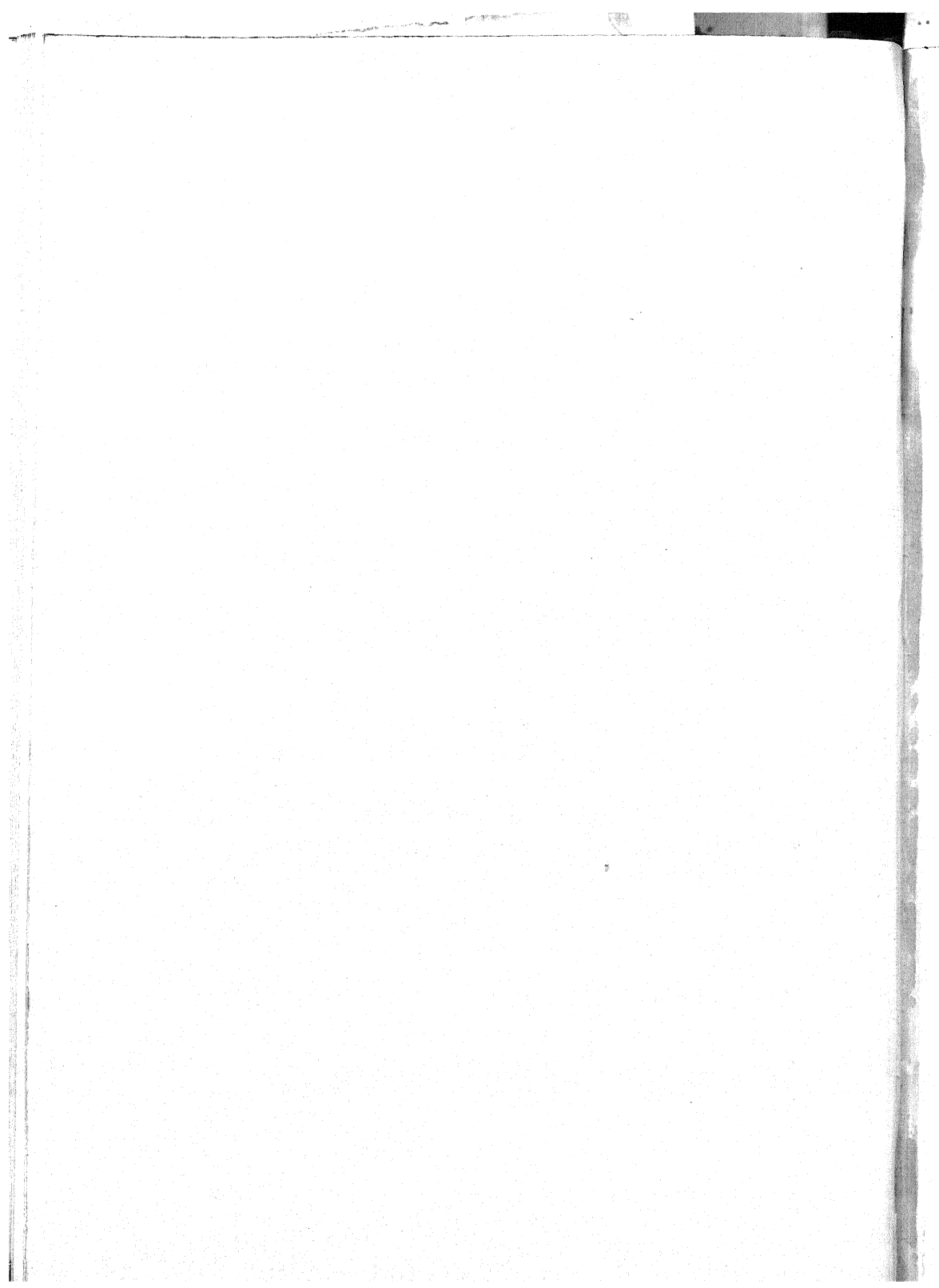
This work was done at The New York Botanical Garden under the direction of Dr. B. O. Dodge to whom I wish to express appreciation for suggestions and criticisms. I am also indebted to Miss Marjorie Swift, for the necessary culture material which was placed at my disposal and for many other courtesies.

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Left. Race 56.3, conidial and sex B, grew faster than race 56.6, nonconidial and sex A. Right. Race 56.7, conidial and sex A, grew faster than 56.2, nonconidial and sex B. Here the conidial races grew faster in both cases than did the nonconidial races. No sex linkage.



PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XVIII. RARE SPECIES OF GODRONIA¹

FRED J. SEAVER

(WITH PLATE 15)

The genus *Godronia* was established by J. B. Mougeot in 1845 who characterized it as having apothecia which are coriaceous or gelatinous but with the spores of a *Stictis*. While typically the spores of the genus are filiform the limits have been somewhat extended to include those forms in which the spores are much elongated and fusiform. It is difficult to segregate arbitrarily on this basis. Hence a number of species have been included which might appear to belong elsewhere. The genus overlaps *Scleroderis* of the Phacidiales so that some of the species have been used interchangeably between the two and in fact it has been suggested by some mycologists that the genera are identical.

During two collecting trips to Colorado among other collections the writer obtained two rare species of the genus *Godronia*. The first of these has been twice described as new first by Ellis and Everhart, later by the writer but is now found to be synonymous with an old European species, as brought out in the accompanying treatment. The second has been extensively known in this country in its conidial stage but does not seem to have been so commonly collected in its perfect form. For these reasons it is thought well to describe and illustrate the two species giving our present conception of their synonymy. Both have been found accompanied by their conidial stages which adds interest to the problem.

SCLERODERRIS FULIGINOSA (Fries) Karst. Myc. Fenn. 1: 216.
1871.

Sphaeria fuliginosa Pers. Obs. Myc. 2: 68. 1799.

Cenangium fuliginosum Fries, Elench. Fung. 2: 23. 1828.

¹ This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

Lasiosphaeria striata Ellis & Ev. Proc. Acad. Sci. Phila. 1893: 443.
(1894?)

Godronia Betheli Seaver, Mycologia 3: 64. 1911.

Godronia striata Seaver, Mycologia 4: 123. 1912.

Apothecia erumpent through the outer bark, of the host, single or occurring in clusters, often so numerous as to form congested masses many cm. in extent and often almost entirely surrounding the branches on which they grow, the individual apothecia at first nearly globose, opening at the top so as to leave an irregular margin, at maturity about 1 mm. broad and the same in height, brownish and furfuraceous externally and longitudinally striated; hymenium whitish or bluish-white; asci clavate, reaching a length of $130\ \mu$ and a diameter of $7-8\ \mu$, 8-spored; spores fasciculate in the ascus, subfiliform, tapering toward either end, sharp-pointed, $3-4 \times 65-85\ \mu$, becoming 7-septate at maturity and often slightly constricted at the septa, hyaline; paraphyses abundant, filiform.

Pycnothecia often accompanying the apothecia at first closed becoming shallow cup-shaped, usually black; pycnospores fusiform, straight or slightly curved, 3-septate, $3-4 \times 28-30\ \mu$.

On branches of *Salix*.

TYPE LOCALITY: Europe.

DISTRIBUTION: Ontario and Colorado; also in Europe.

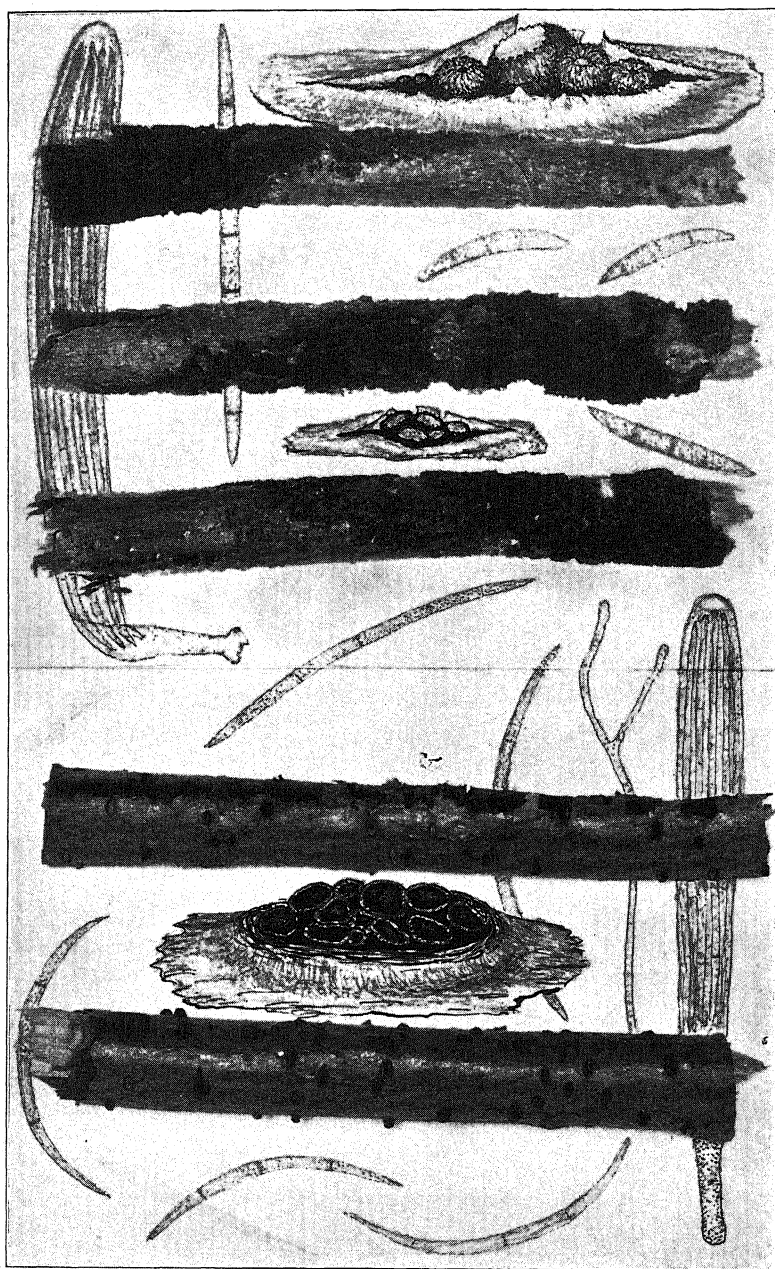
ILLUSTRATIONS: Tul. Fung. Carp. 3: pl. 20, f. 1-4; E. & P. Nat. Pfl. 1¹: 255, f. 187, H-J.

This species was collected in abundance on willow at Tolland, Colorado by the author in company with Ellsworth Bethel in 1910 and described as a new species, *Godronia Betheli*. Later study revealed the fact that *Lasiosphaeria striata* Ellis & Ev. is identical but owing to the fact that it had been placed in the Sphaeriales it had been overlooked. The young apothecia are strongly constricted which doubtless accounts for the fact that Ellis placed it in that group. Recent study has revealed the fact that both Ellis & Everhart's species and the species of the writer are identical with *Cenangium fuliginosum* of Fries.

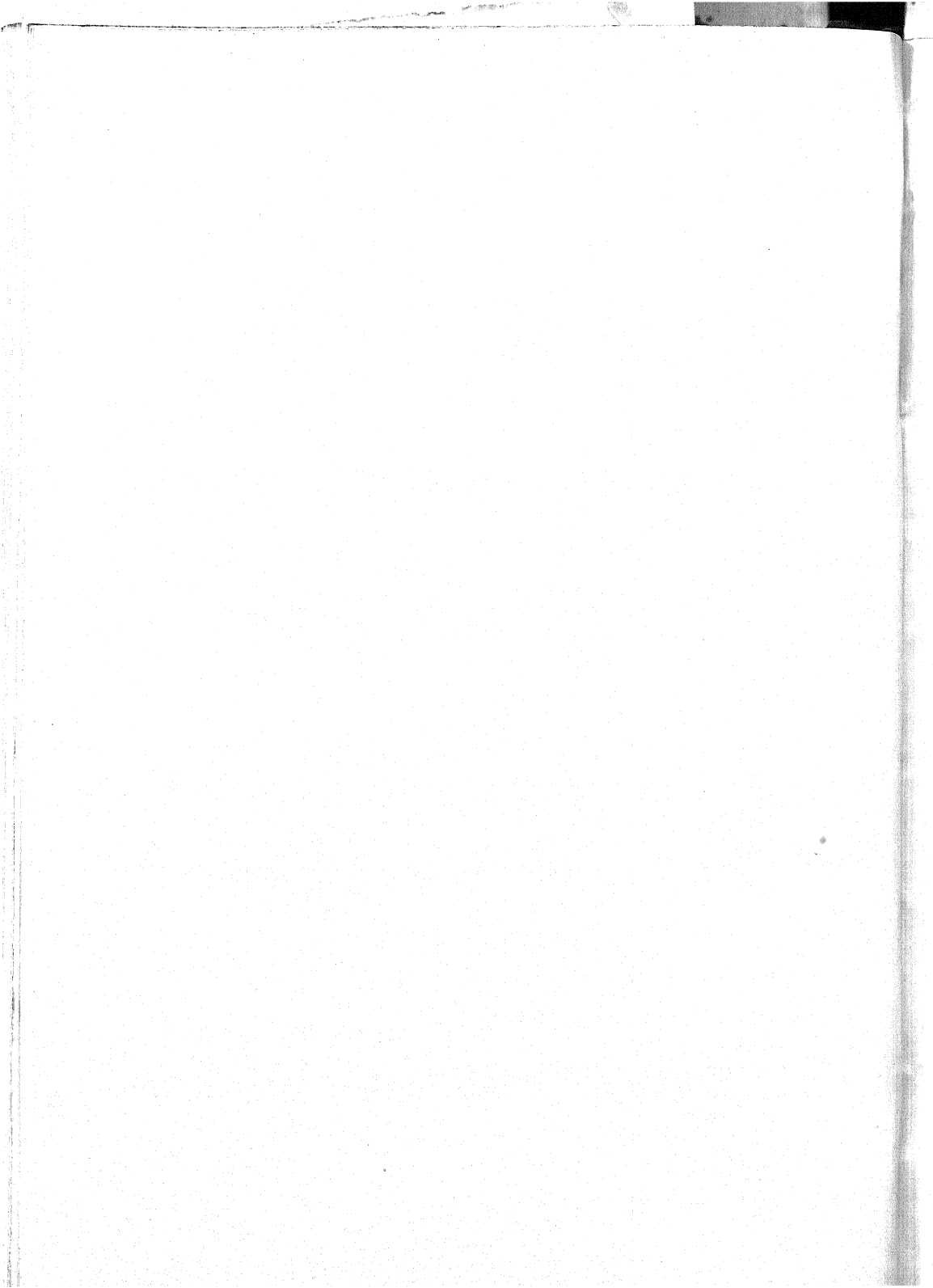
SCLERODERRIS SERIATA (Fries) Rehm, in Rab. Krypt., Fl. 1³: 211.
1899.

Cenangium seriatum Fries, Syst. Myc. 2: 185. 1822.

Phacidium seriatum Fries, Elench. Fung. 2: 131. 1828.



GODRONIA FULIGINOSA
GODRONIA SERIATA



Triblidium seriatum Fries, Sclerom. Suec. 161.

Dermatea seriata Tul. Fung. Carp. 3: 160. 1865.

Gelatinosporium betulinum Peck, Ann. Rep. N. Y. State Mus. 25: 84. 1873.

Apothecia occurring in elongated clumps 3–4 mm. long and about 2 mm. broad closely compressed together and often slightly irregular from mutual pressure, entirely black, reaching a diameter of .5 mm.; hymenium slightly concave, bordered by a slightly up-turned margin, black; asci clavate, reaching a length of 95–110 μ and a diameter of 10–12 μ , 8-spored; spores long, fusiform and usually slightly curved when free, reaching a length of 45–60 μ and a diameter of 2–3 μ , 3-septate, paraphyses slender, branched, hyaline or subhyaline.

The conidial stage accompanies the ascigerous and consists of a blackish stroma in which the pycnosporos are produced; pycnosporos fusiform strongly curved and 3-septate, reaching a length of 40–45 μ from tip to tip and a diameter of 2–3 μ .

On *Betula lutea* and *Betula fontinalis*.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Pennsylvania and Colorado; also in Europe.

EXSICCATI: N. Am. Fungi 537–537b; Fungi Columb. 853; Shear, N. Y. Fungi 200.

A fine collection of this species was obtained in Coal Creek Canon, Colorado by the writer and Paul F. Shope in the summer of 1929 (No. 495) and determined by Mr. W. W. Diehl as *Scleroderris seriata* (Fries) Rehm. This is the only perfect specimen of this species in the herbarium of The New York Botanical Garden from America.

Material which seems to be a part of the type collection of *Gelatinosporium betulinum* Peck is found in our collection. A note apparently in the handwriting of C. H. Peck reads as follows: "Perhaps the same as *Sphaeronema seriatum* B. & C. possibly a condition of *Cenangium seriatum* Fr." This conclusion is undoubtedly correct since our material collected in Colorado shows both stages on the same stroma. The pycnosporos agree very closely with those from Peck's type. No definite pycnidia could be detected.

DISTRIBUTION OF WEST INDIAN RUSTS

H. W. THURSTON, JR., AND F. D. KERN

During the winter of 1931-32 while working with the rust flora of the Dominican Republic, we found it advantageous to prepare an index of all known species of West Indian rust fungi. Certain facts have become apparent from a study of this index that seem worthy of record and comment. Arthur (2) in 1917 gave a short collective account of the West Indian rusts as known at that time, in which he gave the total number of species as 214. Further study has resulted in reducing several of these to synonymy but further collecting in the Islands has added many new forms so that the present total is 290 species. Prior to the collecting of Stevens in Porto Rico 1913-15 it was the general impression of mycologists that rusts were scarce and uninteresting in these regions. As a result of Steven's work the total number of species was brought up to 155 (Arthur 1, 2). Arthur states that had a list been compiled before the Steven's material was available it would have numbered less than 100. Among previous collectors having a knowledge of the Uredinales were Clinton and Holway in Porto Rico and Earle in Cuba.

TABLE I
TABULAR VIEW OF RUSTS KNOWN FROM WEST INDIES AT VARIOUS TIMES

Prior to 1915	1915	1916	1917	1932
100	155	174	214	290

Following Arthur's brief account in 1917, which included the Cuban list (5) although this list was not published until the following year, little systematic collecting was done in the Islands until 1924 and no papers of any extent dealing with the rusts of the region appeared until 1926. In 1926 Kern and Whetzel (8) added 12 species from Porto Rico; in 1928 Kern (6) added 13 from Santo Domingo; in 1930 Kern and Ciferri (9) 6 more from Santo Domingo; in 1932 Kern (7), and in 1933 Kern, Ciferri and

Thurston (10) added 28 from Porto Rico and Santo Domingo. Other collections from the Islands have been reported in different publications and most of these have also appeared in the various parts of the North American Flora (Vol. 7), bringing the total number of species as at present understood to 290 as already stated.

Arthur (4, p. 177) has well set forth the incompleteness of our knowledge regarding the distribution of rust fungi, and has discussed the cogent reasons for this state of affairs. No claim to completeness so far as distribution is concerned is made for the West Indian figures here presented. They represent merely an accounting which has not been attempted for this region for fifteen years. Using the figure 1200 as given by Arthur (4, p. 180) for the total number of the rusts of North America, in the West Indies are thus seen to occur between one fifth and one fourth of the known North American forms.

TABLE II

NUMBER OF WEST INDIAN RUSTS IN RELATION TO THEIR DISTRIBUTION ELSEWHERE IN THE WORLD

No. Known from West Indies Only	No. Known Also Only from Conti- nental North America	No. Known Also Only from Conti- nental South America	No. Known Also from Both North and South America	No. Known Also from Both Eastern and Western Hemispheres	No. Known Also Only from Eastern Hemisphere
71 or 24.1%	68 or 23.6%	50 or 17%	49 or 16.9%	43 or 15%	9 or 2.7%

By combining columns 1, 3, and 6 in Table II we find that there are 130 species from the West Indies not otherwise recorded in the flora of North America. Thus the Islands have contributed about one out of every 10 rusts known in North America. As a whole the rust flora of the Islands resembles that of North America only slightly more than that of South America. When the South American flora is better known this difference may change or disappear.

The distribution of the 290 species among the various islands of the West Indies is shown in Table III. This table reflects the extent and thoroughness of collecting in the individual islands rather than the real distribution. More time spent in collecting

and study of the less well represented areas will no doubt extend the records of distribution of a large number of species. The increase in our knowledge of West Indian rusts and their distribution is, however, strikingly apparent, and is here well illustrated by the figures from Santo Domingo, where the number of species known has increased from 4 in 1918 to 180 in 1932.

TABLE III
KNOWN DISTRIBUTION OF RUSTS IN THE VARIOUS ISLANDS OF THE WEST INDIES

Island	1918	1932	1932 No. Known Only from
Porto Rico.....	157 ¹	187	26
Santo Domingo.....	4 ²	180	33
Cuba.....	136	162	32
Jamaica.....	32	72	8
St. Croix.....	7	28	1
Bahamas.....	12	27	7
St. Thomas.....	5	21	1
Haiti.....	3	17	
Martinique.....	5	14	
Guadaloupe.....	4	6	
Grenada.....	2	6	
Antigua.....	2	5	1
Tortola.....	1	4	1
Barbados.....	1	4	
St. Vincent.....	1	2	
Montserrat.....		2	
St. John.....		1	
Sinoloa.....		1	
St. Kitts.....		1	
Grand Caymon.....		1	

¹ Arthur, J. C. Myc. 9: 55-104. 1917.

² Arthur, J. C. & Johnston, J. R. Ured. of Cuba. Mem. Torr. Club 17: 97-175. 1918.

The 1918 distribution for all islands except Porto Rico is taken from this paper.

Organized collecting of rust fungi has been undertaken only in the three larger Islands and of these Porto Rico has probably been covered the most thoroughly. In presenting the Cuban list Arthur said, "it is evident that the present showing must be accepted as only a beginning." Incidental collecting in Cuba since that time, 1918, has increased the number of species from 136 to 162, which tends to bear out Arthur's statement. Jamaica never has been systematically searched for rusts, yet the number

of rusts known from Jamaica has gradually increased until it has more than doubled in the period under discussion.

It is of special interest to note the number of species which are known only from the type collections or type locality, 26 in Porto Rico, 33 in Santo Domingo, and 32 in Cuba. Undoubtedly only a few of these will eventually prove to be as rare as the present known distribution would indicate. Recent collections in Santo Domingo have uncovered six undescribed species. These facts are an indication that the West Indies are still one of the most fertile fields in North America for the rust specialist.

TABLE IV
DISTRIBUTION OF WEST INDIAN RUST SPECIES BY GENERA

	Total	W. I. Only		Total	W. I. Only
<i>Aecidium</i>	12	8	<i>Kuehneola</i>	1	
<i>Alveolaria</i>	1		<i>Milesia</i>	3	1
<i>Botryorhiza</i>	1	1	<i>Olvea</i>	2	1
<i>Calliopsis</i>	1		<i>Phakopsora</i>	7	2
<i>Cerotelium</i>	4		<i>Prospodium</i>	7	3
<i>Coleosporium</i>	7		<i>Puccinia</i>	119	16
<i>Cronartium</i>	2	1	<i>Pucciniastrum</i>	1	
(includes <i>Cionothrix</i>)			<i>Pucciniosira</i>	1	
<i>Crossopora</i>	2	1	<i>Ravenelia</i>	19	6
<i>Ctenoderma</i>	1		<i>Sphaerophragmium</i>	1	
<i>Desmella</i>	1		<i>Thecopsora</i>	1	
<i>Diabole</i>	1	1	<i>Tranzschelia</i>	2	
<i>Dicheirinia</i>	1		(includes <i>Nephlyetis</i>)		
<i>Endophylloides</i>	1		<i>Uredo</i>	50	27
<i>Endophyllum</i>	3		<i>Uromyces</i>	37	3
<i>Gymnosporangium</i> ...	1		Total.....	290	71

Keeping in mind the impressions of the earlier mycologists that the rust flora of this region was uninteresting and lacked variety it is worthy of note that so many genera are now represented. When attention is given to the fact that 62 species or approximately 20 percent of the known West Indian rusts are now of necessity referred to the form genera *Aecidium* and *Uredo*, *Aecidium* with 12 and *Uredo* with 50 forms, the opportunity for studying not only the taxonomy, but the biology of the rusts in this region becomes apparent. In addition to the 50 *Uredo* forms, the other spore stages of which are totally unknown, there is a large proportion of the remaining species, Arthur (2) says 65 per cent, that habitually propagate in this region almost entirely by

means of urediniospores. No locality of equal area in North America offers a better opportunity to study the effects of environment upon life cycle, or possesses a larger number of imperfectly understood species which might be straightened out by culture methods, or by manipulation of host and environmental factors, to produce additional spore stages.

To promote further observations and investigations of the species now referred necessarily to the form genera *Aecidium* and *Uredo* we are presenting herewith a list which includes the host genera and the localities.

CHECK LIST OF WEST INDIAN RUST SPECIES REFERRED TO THE FORM GENERA
AECIDIUM AND UREDO

A. AECIDIUM

1. *Aecidium abscedens* Arth., on *Randia*; Porto Rico, Santo Domingo.
2. *Aecidium Borreriae* Pat., on *Hemidiodia*; Porto Rico, Santo Domingo, Guadeloupe.
3. *Aecidium Bourreriae* Holw., on *Bourreria*; Bahamas.
4. *Aecidium Cordiae* P. Henn., on *Varronia*; Santo Domingo, Haiti.
5. *Aecidium domingensis* Kern & Cif., on *Baccharis*; Santo Domingo.
6. *Aecidium Farameae* Arth., on *Faramea*; Santo Domingo, Cuba.
7. *Aecidium favaceum* Arth., on *Phyllanthus*; Porto Rico, Santo Domingo.
8. *Aecidium hispaniolae* K. C. T., on *Solanum*; Santo Domingo.
9. *Aecidium Ixorae* Arth., on *Ixora*; Cuba.
10. *Aecidium Pisoniae* Arth. & Johnston, on *Pisonia*; Cuba.
11. *Aecidium simplicius* Arth. & Johnston, on *Tecoma*; Cuba.
12. *Aecidium Tournefortiae* P. Henn., on *Tournefortia*; Porto Rico, Santo Domingo, Cuba.

B. UREDO

1. *Uredo amicosae* Arth., on *Chrysophyllum*; Porto Rico.
2. *Uredo Anthurii* (Hariat) Sacc., on *Anthurium*; Porto Rico, Santo Domingo.
3. *Uredo Artocarpi* Berk. & Br., on *Artocarpus* & *Castilloa*; Porto Rico, Santo Domingo, Cuba.
4. *Uredo bauhiniicola* P. Henn., on *Bauhinia*; Cuba.
5. *Uredo Bixae* Arth., on *Bixa*; Porto Rico, Santo Domingo.
6. *Uredo Borreriae* (P. Henn.) Kern & Whetzel, on *Borreria*; Porto Rico.
7. *Uredo Buchenaviae* Kern & Whetzel, on *Buchenavia*; Porto Rico.
8. *Uredo bullula* Kern, on *Eupatorium*; Santo Domingo.
9. *Uredo Campeliae* Kern & Whetzel, on *Campelia*; Porto Rico.
10. *Uredo Cephalanthi* Arth., on *Cephalanthus*; Cuba.
11. *Uredo Chardonii* Kern, on *Bouteloua*; Porto Rico.
12. *Uredo Cherimoliae* Lagerh., on *Annona*; Cuba.
13. *Uredo Clusiae* Arth., on *Clusia*; Porto Rico.
14. *Uredo Coccolobae* P. Henn., on *Coccolobis*; Porto Rico, Cuba, Santo Domingo.

15. *Uredo cumula* Arth., on *Buchnera*; Cuba.
16. *Uredo Cupheae* P. Henn., on *Ginoria* & *Parsonsia*; Porto Rico, Santo Domingo, Jamaica, Cuba.
17. *Uredo curvata* Arth., on *Inga*; Cuba.
18. *Uredo dioscoreicola* K. C. T., on *Dioscorea* & *Rajania*; Porto Rico, Santo Domingo, Cuba.
19. *Uredo egenula* Arth., on *Sporobolus*; Jamaica, Santo Domingo.
20. *Uredo Eichorniae* Frag. & Cif., on *Eichornia*; Santo Domingo.
21. *Uredo Erythroxylonis* Graz., on *Erythroxylon*; Porto Rico, Cuba.
22. *Uredo Guacae* Mayor, on *Epidendrum* & *Spathiger*; Porto Rico, Santo Domingo.
23. *Uredo guaynabensis* Kern & Whetzel, on *Jussiaea*; Porto Rico, Jamaica, Cuba.
24. *Uredo Gynandrearum* Corda, on *Habenaria* & *Prescottia*; Porto Rico, Santo Domingo, Jamaica, Cuba.
25. *Uredo Hameliae* Arth., on *Hamelia*; Porto Rico, Santo Domingo.
26. *Uredo Hymenaeae* Mayor, on *Hymenaea*; Porto Rico, Santo Domingo, Cuba.
27. *Uredo ignava* Arth., on *Bambos*; Porto Rico, Santo Domingo, Jamaica, Cuba.
28. *Uredo incomposita* Kern, on *Eleocharis*; Porto Rico, Santo Domingo.
29. *Uredo jatrophicola* Arth., on *Adenoropium* & *Curcas*; Porto Rico, Santo Domingo, St. Croix, Cuba.
30. *Uredo Kyllingae* P. Henn., on *Kyllinga*; Porto Rico, Santo Domingo.
31. *Uredo laeticolor* Arth., on *Operculina*; Porto Rico, Cuba.
32. *Uredo Lucumae* Arth. & Johnston, on *Lucuma*; Cuba.
33. *Uredo lutea* Arth., on *Chamaefistula*; Porto Rico.
34. *Uredo nigropuncta* P. Henn., on *Bletia*; Porto Rico, Santo Domingo, Haiti, Bahamas, Cuba.
35. *Uredo Ornithidii* K. C. T., on *Ornithidium*; Santo Domingo.
36. *Uredo Polytaenii* K. C. T., on *Polytaenium*; Porto Rico, Santo Domingo.
37. *Uredo Piperis* P. Henn., on *Peperomia*; Porto Rico.
38. *Uredo pustulata* P. Henn., on *Stenorrhynchus*; Porto Rico.
39. *Uredo Rousseliae* Kern & Whetzel, on *Rousselia*; Porto Rico.
40. *Uredo rubescens* Arth., on *Dorstenia*; Porto Rico, Santo Domingo.
41. *Uredo sabiceicola* Arth., on *Sabicea*; Porto Rico.
42. *Uredo Sapotae* Arth. & Johnston, on *Sapota*; Santo Domingo, Bahamas, Cuba.
43. *Uredo Sauvagesiae* Arth., on *Sauvagesia*; Porto Rico.
44. *Uredo Saviae* Arth. & Johnston, on *Savia*; Cuba.
45. *Uredo Sparganophori* P. Henn., on *Struchium*; Porto Rico, Santo Domingo, Jamaica, Cuba.
46. *Uredo Toroiana* Kern, on *Vernonia*; Santo Domingo, Haiti.
47. *Uredo Trichiliae* Arth., on *Trichilia*; Porto Rico.
48. *Uredo uncinata* K. C. T., on *Dorstenia*; Porto Rico, Santo Domingo.
49. *Uredo vicina* Arth., on *Wedelia*; Porto Rico.
50. *Uredo Wilsoni* Arth., on *Anaethaphia*; Bahamas.

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NOTES AND BRIEF ARTICLES

Beginning with the present number, the dates of publication of *Mycologia* will be: February 1st, April 1st, June 1st, August 1st, October 1st, and December 1st, instead of January 1st, March 1st, May 1st, July 1st, September 1st, and November 1st. This arrangement will allow more leeway in the publication of the first and last issues containing, respectively, the report of the annual meeting of the Mycological Society of America and the volume index.

FAULL'S MONOGRAPH OF THE GENUS *MILEsia* ¹

A notable and more than usually important addition to the literature of the Uredinales is embodied in this comprehensive treatise of the most unique and least understood genus of all the rusts. In taxonomic treatment it evaluates each historical reference both as to genus and species, and for geographical distribution embraces all known material throughout the world.

The genus is one of the two white-spored genera of rusts inhabiting ferns, and is here adequately described for the first time. The urediospores are a predominating feature, although teliospores are not uncommon and were present but overlooked in the establishment of the genus. Both telia and aecia, the latter on *Abies*, may afford some taxonomic aid, but are less important in this respect than the urediospores. The key to species is based wholly upon uredinial characters and is illustrated with figures of urediospores drawn to a uniform scale. Thirty-three species and two varieties are described, thirteen as new, of which the aecia are known for nine species, and the telia for twenty-four species and varieties. Most of the species are best collected on the over-wintered fronds.

In selecting the generic name to accord with the present International Rules of Nomenclature it is pointed out that two

¹ Faull, Joseph Horace. Taxonomy and geographical distribution of the genus *Milesia*. Contr. Arnold Arboretum, Harvard Univ. II. 138 pp., 9 pl. 1932.

interpretations may be placed on Rule 49 *bis*. Either the "perfect state," which is made the essential basis for an acceptable name, may refer to the haploid stage in which both uredia and telia are produced from the same mycelium, and which are therefore not comparable to conidia and asci in the Ascomycetes, or, judging from the examples appended, the "perfect state" may refer to the telia and teliospores alone.

The author relies upon the first interpretation in selecting the generic name *Milesia* and is led to anticipate that the Rules will eventually be emended to remove the ambiguity. Those who are interested in the validity of names originally based in part or wholly on uredinial characters will find in the first few pages of the monograph an unbiased and judicial statement of the controversy pertaining to the value of "uredo names," as illustrated by the genus *Milesia*.

J. C. ARTHUR.

The Mycological Society of America

The Mycological Society of America held its first annual meeting December 28, 29, and 30 in the Hotel Traymore at Atlantic City, New Jersey, in affiliation with the American Association for the Advancement of Science. The sessions were well attended, and the meeting as a whole was outstandingly successful. Forty papers illustrating a wide and varied interest within the general field of mycology were presented. Papers on Phycomycetes and on aspects of sexuality in Ascomycetes and rusts were especially numerous. The Society held a joint session with Section G and another with the American Phytopathological Society.

At the foundation of the Society the preceding December in New Orleans an organizing committee of five members had been named. This committee, composed of president Wm. H. Weston, Jr., secretary-treasurer H. M. Fitzpatrick, and councilors H. S. Jackson, C. R. Orton, and N. E. Stevens, gave consideration during the year to the problems confronting the Society, and sent out an invitation to charter membership to mycologists in general which brought forth a very gratifying response. At Atlantic City in an open business session under the chairmanship of president Weston the Society completed its organization. A con-

stitution and by-laws were adopted. The journal MYCOLOGIA became the official organ of the Society on terms previously arranged with The New York Botanical Garden, and the following officers and editors were elected.

OFFICERS

C. L. Shear.....	<i>President</i>
G. W. Martin.....	<i>Vice-president</i>
H. M. Fitzpatrick.....	<i>Secretary-treasurer</i>
H. S. Jackson.....	<i>Councilor</i>
C. R. Orton.....	<i>Councilor</i>

EDITORIAL BOARD

F. J. Seaver, <i>Editor-in-chief</i>
G. R. Bisby
H. M. Fitzpatrick
E. B. Mains
J. A. Stevenson
F. A. Wolf

The editorial board elects its editor-in-chief annually. For 1933 it chose F. J. Seaver, who has also been designated by The New York Botanical Garden as managing-editor.

The vice-president was empowered to arrange for a summer meeting at such time and place as he shall select. It is expected that this meeting will be primarily of the nature of a foray. The hope has been expressed in various quarters that the importance of this annual get-together in the field will be generally recognized, and that all will cooperate in making it a complete success.

The Society begins its active existence with a charter membership of approximately three hundred and fifteen. It is expected that this number will be increased appreciably during the coming year. All persons interested in the fungi are eligible to membership. The annual dues of five dollars entitles the member to receive MYCOLOGIA. Applications for membership should be addressed to the secretary-treasurer. A group photograph of the mycologists was taken at one of the sessions in Atlantic City. A key to this is available.

H. M. FITZPATRICK.

PLANT SCIENCE BUILDING,
CORNELL UNIVERSITY,
ITHACA, NEW YORK.



DR. THAXTER WITH BOBBY ON THE STEPS OF HIS HOME AT KITTERY POINT
ON THE OCCASION OF HIS 70TH BIRTHDAY.

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXV

MARCH-APRIL, 1933

No. 2

ROLAND THAXTER¹

WM. H. WESTON, JR.

(WITH PLATES 16 AND 17)

In the history of any science the influence of an occasional outstanding man, both through his own work and through the activities of men trained by him, leaves a lasting impression on the field which was peculiarly his own. In Mycology Dr. Thaxter was such a figure, and his death on the 22d of April is a loss deeply felt not only in this field but also in Botany as a whole. Perhaps, because he exerted such a distinct influence, it may be fitting to record here some notes on his life, his work, and his personality, more for the benefit of younger men who, although they have known his work, unfortunately never had the opportunity to meet him, than for his contemporaries to whom he was better known.

Roland Thaxter was born in Newtonville, Massachusetts, August 28, 1858, his inheritance from both his parents being an unusual one. His father, Levi Lincoln Thaxter (Harvard 1843), although trained in Law was by nature and inclination a scholar, an authority on the life and works of Browning, with a considerable reputation in the field of literature, a respected and well loved member of a literary and artistic group comprising such men as James Russell Lowell, Henry D. Thoreau, Thomas Bailey Aldrich, Nathaniel Hawthorne, and William Morris Hunt. His mother, Celia Laighton Thaxter, will always be remembered for

¹ Presented in part at the first meeting of the Mycological Society of America held in Atlantic City December 28-30, 1932.

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her poetry, in which her love of nature and her deep religious feeling were manifest. To the unusual qualities of his parents, to the scholarly and cultured atmosphere of their home, and to their material and spiritual encouragement is attributable much of Dr. Thaxter's character and ability.

In his early years he attended several schools, among them the Boston Latin School, and finally from the private school of Joshua Kendall in Cambridge he entered Harvard in the autumn of 1878, receiving in 1882 the degree of A.B., Magna Cum Laude, with honorable mention in Natural History and English Composition. He was one of the outstanding members of this class of 1882, which among 182 who graduated (227 having started as freshmen), after 25 years comprised five professors and one widely known instructor on the Harvard Faculty and 11 in other universities, and a list of 28 in Who's Who, including, in branches other than academic, notable doctors, lawyers, authors, financiers, politicians, and diplomats. The year after graduation, 1882-1883, Dr. Thaxter himself has described as mostly lost because an accident at the end of his senior year kept him practically on his back for nine months, in spite of which he mentions "work done, mostly biological, in entomology, one or two short papers published." In the autumn of 1883 he entered Harvard Medical School and although, after a few months, imperative duties demanded much of his time at home, yet he passed the examinations and started the second year with his class. Meanwhile, however, he had received the Harris Fellowship, a two-year appointment which enabled him to leave the Medical School and enter the Graduate School of Arts and Sciences, an important step in his career, as he concentrated in research in Cryptogamic Botany under Dr. Farlow, with whom he served as assistant from 1886 to 1888, published his first mycological paper, "On Certain Cultures of Gymnosporangium with Notes on their Roesteliae," in 1887, and in 1888 received the degrees of M.A. and Ph.D. in Natural History, his thesis being a monograph, "The Entomophthorae of the United States," published the same year. After a brief interlude tinged with plant pathology and applied mycology at the Connecticut Agricultural Experiment Station from 1888 to 1891, he was called back to Harvard to an assistant professor-

ship as Dr. Farlow's associate, and continuing in this capacity took on the full responsibilities of Cryptogamic Botany when in 1896 Dr. Farlow relinquished the instructing of undergraduates although still continuing the guidance of some of the graduate research students. In 1901 Dr. Thaxter became full professor, the position he occupied until 1919, when, after Dr. Farlow's death, he became Professor Emeritus and Honorary Curator of the Farlow Library and Herbarium, having retired voluntarily in order to pursue his own research uninterrupted.

The scope of Dr. Thaxter's work and the extent of his intimate knowledge of the fungi as revealed by the many papers which he published (see list) are most unusual and impressive. To be sure, his monographic work on the Laboulbeniales is his most monumental contribution to mycology, but fundamental and important work on many other groups is evidence of his indefatigable investigations and his wide knowledge. Early in his career he established the Myxobacteriaceae, a new order of the Schizomycetes, characterized by a vegetative phase of distinct, rod-like individuals swarming in masses in a gelatinous matrix, which by their concerted action form fruiting bodies of various degrees of complexity. This life history, resembling somewhat that found in the Acrasiales, was so aberrant and unusual among the Schizomycetes that much controversy resulted among pathologists and mycologists after the publication of Dr. Thaxter's first paper in 1892. Yet the convincing evidence of this paper and later ones of 1897 and 1903, corroborated by other investigators, established the group with certainty so that by now it occupies an accepted place in classification and is included even in textbooks of bacteriology. Furthermore, not only his monograph of the Entomophthoraceae and his comprehensive revision of the Endogoneae but also a series of papers on the Zygomycetes and one on new or peculiar aquatic fungi, comprise a significant contribution to our knowledge of the Phycomycetes. In the case of the Ascomycetes several papers on such unusual genera as *Wynnea*, *Myxotheca*, *Midotis*, *Ionomidotis*, and *Cordierites*, as well as discussions of interesting new species of *Uncinula* and *Taphrina*, together with studies of the perfect stage of *Aschersonia*, are evidence of his interest and investigations beyond his chosen

Laboulbeniales. Among the Fungi Imperfecti a series of contributions describing in detail a considerable list of new and interesting genera such as *Heterocephalum*, *Cephaliophora*, *Desmidiospora*, *Gonatorrhodiella*, and others revealed his knowledge of this vast and perplexing group. In the Basidiomycetes papers on the unusual rust *Maravalia* and the rare phalloid, *Phallogaster*, as well as reports on smuts of onion and other hosts are concrete evidence of his attention to that group. Indeed, although he never published on the Hymenomycetes and avoided study of the fleshy and edible representatives, his knowledge of the more obscure lower Basidiomycetes was very comprehensive, far more than is revealed by these relatively few papers. In addition, his two miscellaneous papers on fungous parasites of living insects not only described many interesting forms new to mycology, but covered a wide range of fungi, chiefly among the imperfect fungi and Ascomycetes, to a lesser degree among others of doubtful affinities.

Although Dr. Thaxter is known primarily for his work in mycology, he was by no means limited to this field alone. He had an unusual knowledge of the algae, and although he published but one paper on "The Structure and Reproduction of Compsopogon" he had made large and well chosen collections of both fresh water and marine forms, some of them worked over in detail by Dr. Farlow, others studied, identified, and then added either to the Farlow Herbarium or to the valuable collections in the Botanical Museum. Similarly Dr. Thaxter had an intimate familiarity with the Bryophytes and although he never published concerning them he had studied them under their natural conditions during his travels and had made extensive discriminating collections that became valuable additions to the Farlow Herbarium and to the collections of various specialists in this field. He had given considerable attention to lichens as well, his knowledge of them was unusual, and although but one of his publications deals with them, the specimens which he gathered with keen discernment during trips to such places as the British West Indies became the basis of papers by Vainio, Riddle, and others to whom the material was generously furnished.

All of his occasional papers, however, he regarded as mere side

issues, referring to them by the derogatory diminutive of "Opuscula," yet these alone would have given him eminence as a mycologist had he never followed his main line of investigation, the monumental work on the Laboulbeniales for which he will be forever renowned throughout the scientific world. The course of this main line of his work follows a historical sequence of development as logical as that traced for the different phases of Pasteur's investigations by Duclaux. His first interest in biology was divided between insects and fungi, and very early he acquired a thorough groundwork in both groups which enabled him to appreciate the importance of the biologic aspects of their interrelationship. Naturally he became interested in the parasitism of insects by fungi, perhaps the most involved and significant phases of the intricate association between these two diverse and extensive groups. It was this field, therefore, that he chose for his doctorate work, and his thesis, the well known "Monograph of the Entomophthoraceae," was not only a most comprehensive and able contribution in itself but also a significant step in the undertaking of his life work. In spite of the phytopathological demands of his first position he was not diverted from his set purpose of extending his studies in this field to the other groups of fungi parasitic upon insects, and it was not long before he began an investigation of *Cordyceps*, *Isaria*, and related forms on which he continued work throughout his life, gathering extensive collections of material and literature, and although he never published a monographic study of the group, his paper on *Aschersonia* in 1914 was a valuable contribution and he was sought as an authority by others whose research lay in the same field. As his investigations reached out to other groups his appreciation of the significance and importance of the field opened up by Leidy's classic "Flora and Fauna of Living Animals" led him to investigate the fungi parasitic in the intestines of insects. After some years he described a few of these fungi in miscellaneous notes, extending Leidy's contributions by descriptions of additional Enterobryeae and related forms. Continuing ever farther in his chosen field he was led into studies of the entomogenous Fungi Imperfecti, work which he continued intermittently for years and on which he published two short but important contributions in 1914 and

1920. Through all these years also he continued his interest and his work in the Entomophthoraceae, being widely recognized as an authority in this group. It is noteworthy that although interested chiefly in such primarily biologic matters as the morphology, development, host range, and distribution of these several groups of entomogenous fungi with which he concerned himself, yet he had a keen realization of the possibilities of their economic application to insect control and was the instigator of successful work in this applied field done by such men as Speare and Rorer.

Early in his investigations he began his study of the Laboulbeniales, a group then practically unknown, and as he developed his technique of collecting, mounting, studying, and drawing these organisms, he soon became increasingly absorbed in them as he found them to be a veritable *terra incognita* opening up the limited yet paradoxically extensive field that was to become his life work. The first volume of his investigations, modestly entitled "A Contribution towards a Monograph of the Laboulbeniaceae," was published in December, 1896, a quarto volume of 429 pages and 26 plates which not only covered the taxonomic consideration of genera, species, and families, but discussed general matters of the morphology and development of these organisms as well as their occurrence, distribution, and relation to the insect host. So complete, so comprehensive, accurate, authentic, and beautifully illustrated was this volume that it at once gave Dr. Thaxter international recognition and the four volumes that have followed since then have augmented this. The second contribution, which appeared in 1908, increased the total number of species and varieties to about 500, and in addition presented further significant facts of development, distribution, and other matters of general interest. Following this, nine preliminary papers added an almost equal number of additional species, while Part 3, which appeared in 1924, extended the same searching taxonomic study to additional families not previously treated in detail. Part 4, appearing in 1926, continued this monographic treatment of the group, increasing our knowledge of these organisms to an extent which may be gauged by the fact that it brings the genus *Rickia*, established on *R. Wassmanni* by Cavara in Europe in 1899 and

formerly comprising but two species, to over 100 species worked out in exacting detail and exquisitely illustrated. Moreover, this as well as the other volumes was a monographic treatment in the broadest sense of the word, being by no means confined to a mere taxonomic discussion of genera, species, and families; indeed, it should be noted that Dr. Thaxter's descriptions of the development were so detailed that the later work of others using serial sections and modern cytological technique have added little to his presentation of the nuclear conditions involved, while his discussion of the different sex conditions of unisexuality and bisexuality involving self fertilization and cross fertilization are almost prophetic in their fundamental grasp of conditions which recent work has shown to exist in other groups.

When working on Volume 5, which was published in 1931, Dr. Thaxter planned to complete the series in this volume with a systematic treatment of the species which had been collected and described since earlier parts appeared, and a final consideration of host range, distribution, and other points of general interest. The number of species proved to be so large, however, that he was forced to restrict the number of illustrative figures to 1136, comprised in 60 plates, to limit the specific descriptions, and to defer the general discussions. In 1932, therefore, he was at work on the additional species of the genus *Laboulbenia* whose number had precluded their inclusion in the previous volume, had completed many of the illustrations, and was planning with indomitable courage despite increasing handicaps to include the treatment of this large and difficult genus in a final sixth volume with addenda, a general revision of the classification, a host index, and the consideration of the long deferred matters of general biologic interest.

To all who have followed this monograph through these several parts, the tragedy that death cut short his work before he had completed his general consideration of the group in its more general biologic aspects, is an appalling one. This knowledge he alone possessed. Others, with his monograph to help them, undoubtedly can deal satisfactorily with additional species that may be encountered in the future, but the treatment of the group as a whole from its biologic aspects he alone could accomplish.

Through his untimely death it is forever lost. This monograph, the main activity of his life, developing as the logical outcome of his interest in fungi in relation to insects, stands out as one of the greatest single pieces of work of all time in mycology, a monument to his courage and devotion as well as to his productive scholarship.

All of his work, whether his several occasional papers on fungi, his few but important phytopathological reports, or his monographic studies of the Laboulbeniales, was characterized by exhaustive thoroughness and completeness in the work itself, the most exacting accuracy of illustration, and a most effective and well ordered presentation. Yet the student, especially the beginner in mycology, encounters certain difficulties in Dr. Thaxter's publications. Because of his aversion to short, disconnected sentences and his conviction that the style of Thackeray was best suited to scientific exposition, his writing was not always easy to follow; while in his desire to avoid misrepresentation through statements too sweeping and inclusive he was led at times to qualify his statements so cautiously that their interpretation required undue labor on the part of the reader. Also following the earlier custom he gave references in brief footnotes rather than in detailed lists of literature cited, nor did he append to his papers summaries emphasizing the main points comprised, while with his illustrations he never included an absolute scale that would permit comparison of their essential measurements.

In his teaching Dr. Thaxter was at his best with graduate students whose purposive interest and eager enthusiasm for investigation he developed and guided most effectively from his extraordinary knowledge of the fungi and his extensive store of material and literature. He was an exacting master under whom to work, but no student could resent what was demanded of him in faithful adherence to work, painstaking conscientiousness of execution, unremitting accuracy in drawing, and brevity and clarity in writing, because of the realization that Dr. Thaxter was even more exacting and more demanding of himself. In lecturing he was neither fluent nor vivid nor of compelling magnetism, but his direct, sincere presentation and his impressive knowledge of the subject more than made up for any lack of

popular appeal and left a lasting impression even on some of the most uninterested of his classes. Moreover, although his lectures were full of valuable information they were not without occasional gleams of dry humor, of which evidence may be found here and there in notes taken by discerning auditors. In connection with his lectures he used a very condensed syllabus, crammed with facts, closely typed, and reproduced by hektograph with a few of his own illustrative diagrams. Some of us still cherish this outline, and the pages, crowded, faded, and hard to follow, are yet remarkable for the amount of pertinent information they presented in a minimum of space. He always began each lecture with a brief resumé of the previous one, a valuable aid to the student who had missed some points, and for this recapitulation he used the syllabus as a basis.

In the laboratory work of his classes he had to depend on assistants to some extent, especially in the larger general course in Cryptogamic Botany which at times contained 60 to 70 students, but none the less, whether in this or in the smaller, more advanced courses, he always managed to spend some time with each man, and his method of leading the student by skillful questioning in a sort of Socratic dialogue until through the microscope the essential features of structure and development were observed and interpreted correctly, was a revelation in teaching to his assistants who had seen in operation elsewhere the method of providing a detailed laboratory manual which described and illustrated just what the student was expected to work out for himself. It was in the laboratory that Dr. Thaxter was most effective as a teacher, and his training, which developed in his students qualities of intelligent observation and independent investigation, greatly influenced their own research and teaching in later years. In thus training the student, necessarily he emphasized the development of manual dexterity in such delicate manipulations as would reveal hidden details of structure; and as he himself had unusual dexterity, he regarded as unfortunately handicapped that type of student who was quick to absorb recorded knowledge verbatim from lectures and reading, but clumsy and helpless in attempts to accomplish the necessary simple adjustments of the microscope and easy manipulation of material

that would have enabled him to work out things for himself. Of one such student he once said with a sigh, "That man! He never takes a note yet he remembers everything of the lectures, but in the laboratory he hasn't hands, he has hooves."

In Dr. Thaxter's years at Harvard nearly a thousand students worked with him either as undergraduates in one or more of his courses covering general Cryptogamic Botany or the fungi, algae, and bryophytes, or as graduates taking advanced work in research in some of these fields. How great an influence he had on these men may be judged from their enthusiastic letters on the occasion of Dr. Thaxter's 70th birthday in 1928. One student, at that time a professor of English, wrote, "Well do I remember how I stumbled along in his Cryptogamic Botany and how patient and painstaking he was toward me. Even such a dub as I was could not help but realize that he was coming in contact with a remarkable scholar in Dr. Thaxter." Another, then a successful lawyer, wrote, "I think the training I got under Dr. Thaxter was as valuable as any I ever received. With him one learned what it meant to plow a furrow long, straight, clean, and deep in a field of scientific endeavor. With him also one became aware that all organisms are interesting, whether they have legs or not."

To the teaching of Botany it is a great loss that Dr. Thaxter never made available in text-book form his extensive knowledge of the Cryptogams as a whole, or especially of the fungi. His familiarity with the work which had been published in this field and with investigations as yet unpublished but known to him through his extensive correspondence, especially equipped him to accomplish this, and in addition his extensive intimate first hand knowledge of the fungi from his own work furnished him the very requisite which so many who have produced text books that are excellent compilations unfortunately have lacked. Moreover, although he was decidedly opposed to the exploitation of science in popular (and remunerative!) radio talks, lectures, or articles, he had the faculty of writing not only authoritatively but also interestingly and entertainingly, as his account of the Antarctic beech forest and his article on the Farlow Herbarium amply demonstrate. He was urged repeatedly to write a text book but he always replied that he had too much to accomplish and that

the time left him would be too short for him to finish his "job" on the Laboulbeniales. The loss to the teaching of botany resulting from his tenacious devotion to his set purpose is more than balanced by the resulting gain to productive investigation in mycology.

Although he never called attention to his travels by publishing miscellaneous lists of his collections from various parts of the world, and although he never took part in any widely publicized expedition he had traveled far more extensively than is generally realized. Beginning while he was still a student, in 1885 he made a botanical and entomological trip to Newfoundland, spent the summer of 1886 collecting in the White Mountains, and in 1887 collected extensively in the mountains of North Carolina and Tennessee. In 1890 he traveled and collected in Jamaica, in 1897-1898 he devoted his sabbatical leave to study and collecting first in Florida and then in Europe, and in 1900 he again went to Europe for further travel and investigation. The year of 1905-1906 he spent in South America, sailing from Liverpool in August for a month in Buenos Ayres, thence traveling via the Falkland Islands and the Straits of Magellan to Chile for three months in Santiago, Concepcion, and Corral, revisiting the Straits of Magellan for a two months' stay at Punta Arenas in the region of the great Antarctic beech forest, and finally, after seven weeks in the Argentine, returning to Liverpool and thence to Cambridge in June, 1906. Again on sabbatical leave in 1912-1913 he visited the British West Indies, spending some time in Grenada in the mountains above St. Georges, where he made extensive and valuable collections and carried on his work indomitably despite exceedingly unfavorable circumstances, continual torrential rains, constant inroads of destructive moulds and insects among his specimens, exceedingly primitive living conditions, and recurrent illness through which he lost twenty-four pounds in a few weeks. From there, after a brief collecting trip to Tobago, he went to Trinidad where at the hospitable home of J. B. Rorer he regained his health and enjoyed six months of active successful work. It was toward the end of this trip that he wrote Dr. Farlow, "I doubt greatly if I tempt the tropics again for they do not use me well however much I like them."

Although he did not publish lists of collections from such trips and had a horror of the hastily compiled lists and half popular, half botanical travelogues which result from the forays and trips of some botanists, yet his letters to Dr. Farlow and others while on such trips are fascinatingly complete accounts of the cryptogamic flora of the regions which he investigated, replete with information as to the occurrence, location, and conditions of growth of unusual and interesting forms, abounding in vivid, picturesque descriptions of the country and its plants, and touched here and there with a deft and dry humor that made such letters not only authoritative but most interesting accounts. Moreover, he was never content merely to collect material and after hastily examining and listing it, dismiss it to oblivion in his herbarium. Rather, he persistently worked over his material with great thoroughness so that his accumulated collections thus became part of his own great store of knowledge, although unpublished. As a result the extent of these collections and their value to mycology may not be realized for years until, having been made part of the Farlow Herbarium, they are again worked over by others in detail. Always, in his teaching and in his own investigations, he showed keen appreciation of the desirability of first-hand knowledge of fungi and other organisms, not only in the laboratory but also as they grow under natural conditions in the field.

Although perhaps thought of by some as a laboratory investigator because in later years much of the material for his monograph of the Laboulbenias was sent him by collectors in different parts of the world, he was ever a persistent, keen, discriminating collector and kept up his field work until relatively recently. All of the environs of Cambridge he visited with his precisely equipped collecting basket, usually alone although at times accompanied by assistants or friends, either on his bicycle or on foot in the 1890's, or later by trolley, train, or bus, so that he came to know the possibilities of the regions within ten to twenty miles most exactly. He could tell his assistants the very places in the clay beds of the brickyards where *Ricciocarpus natans* and *R. fluitans* could be found in abundance, where *Marsilia* occurred, and where *Anthoceros* could be secured.

the exact shores of ponds in Winchester and Arlington where *Isoetes* might be found, and the very pools of the Mystic River tide flats where *Beggiatoa mirabilis* developed in profusion. Of the haunts of many less known organisms which the ordinary collector fails to discover, he had an intimate first-hand knowledge and he felt keen regret when these were destroyed in the real estate developments inevitable to all suburbs,—the exact pool at Stony Brook where *Araiospora pulchra* occurred, now, alas, filled in by refuse from a nearby stone-crusher, the particular ditch near Lexington where *Monoblepharis insignis* was found, now dry and barren, and the swamp near Fresh Pond where species of *Rhipidium* could be secured on baits of green apple or pear, now filled in with rubbish and supporting a spur track, a laundry, and two gasoline stations. With equal thoroughness he knew the mycology of the more secluded and less invaded territory around Kittery, which through his collections has become the *locus classicus* for many interesting and important species. In his field work he demonstrated conclusively that very remote, inaccessible territory is not the only source of rarities and that important findings reward discriminating and intensive search near home.

Perhaps the outstanding characteristics of his distinctive personality were his stern, undeviating loyalty to his work and to its ideals. Day after day he would be at the laboratory perhaps as early as seven in the morning, and in the afternoon would continue working usually until six o'clock or after. These long hours of work and the tremendous amount of productive investigation he accomplished were carried on in spite of persistent hindrances of illness that would have been insurmountable for any but his unyielding tenacity. Being himself thus wholly devoted to his work, it was only natural that he should expect the same of others, and the example of his unremitting devotion was a stimulus to all those who came in contact with him.

In him also, as in many other great characters, there was a certain grim and indomitable adherence to his chosen course and to his ideals. He was an austere disciplinarian, believing in the salutary effect of discipline on the development of character, a quality some of us have especial occasion to remember. For

example, while becoming familiar with various groups of fungi as a first year graduate student under Dr. Thaxter, I early developed an interest in the Phycomycetes, and on one occasion, after working out and identifying a difficult Pyrenomycete which Dr. Thaxter had given me, injudiciously remarked that I disliked that group and far preferred the Phycomycetes; whereat Dr. Thaxter replied that one with as little knowledge of fungi as I, was hardly qualified to express preference for one group over another, and for weeks thereafter kept me busy working on nothing but Pyrenomycetes. Realizing that enthusiasm had overstepped discretion, and remembering vividly that Dr. Thaxter had once told of forcing himself to work out a set number of problems each day for months until he had mastered a certain phase of mathematics, I devoted myself to Pyrenomycetes.

Although austere and reserved, Dr. Thaxter had a keen appreciation of beauty which was manifest in his love of music, art, and literature. He was an accomplished musician, admiring greatly the formal compositions of Brahms and Beethoven, though looking a little askance at Sibelius and Rimsky-Korsakov. He showed a discriminating appreciation of beautiful works of art and architecture, and he loved good books which sometimes he would read to his friends most effectively in his resonant and expressive voice. Indeed, knowing his sensitiveness to beauty, one could not help but feel that certain groups of fungi attracted him not only because of their scientific interest and importance but also because of the diversity and exquisite nicety of form and structure which they revealed.

Moreover, although not characterized by lightness of heart or irrepressible wit, he had a dry sense of humor which from time to time revealed itself to those associated with him. Once, for example, when several of us, as graduate students, were working in the old laboratory in the top floor of the University Museum, our ranks were increased by a botanist from the West who, in one year's leave, was endeavoring to increase his botanical background by several courses at Harvard. In Botany 20b his lack of knowledge of the fungi was outweighed by his enthusiasm, and when one day *Aspergillus clavatus* appeared in a culture he was much intrigued by this striking organism, and on being told

by his fellow workers that it was an *Aspergillus*, he hurriedly pushed past the partly closed door of Dr. Thaxter's sanctum and announced, "Professor, I have *Aspergillus* here"; whereat Dr. Thaxter, looking up at the unexpected and precipitate visitor, remarked drily, "Ah, yes, *Aspergillus*,—not a rare genus, but an interesting one," and turned without further comment to his Laboulbenias.

His letters also were enlivened by deft and whimsical characterizations of people and situations and enriched by frequent humorous touches. In one letter, for example, acknowledging the receipt of a manuscript destined for the Annals, he enclosed a portion of the envelope in which it had been sent, revealing the student's legend, "Please Do Crush or Fold," with the comment that the post office people as usual had failed to heed the direction on the package.

He was a man of great dignity and self restraint, which gave his quiet comments and suggestions added force. His poise remained undisturbed by such laboratory calamities as the burning out of an autoclave or the failure of lights from blown fuses and carried him unperturbed through unexpected and upsetting occasions.

He had of course certain prejudices, perhaps the most outstanding being his prejudice against smoking. Aside from the fact that he regarded the odor of tobacco smoke as distasteful and unpleasant, he had a deep conviction that smoking would impair the delicate control of the hand necessary for the accuracy of drawing which he regarded as an indispensable essential in mycologic work. For the most part this prejudice affected his students but little, as the habit was not so general as it is now, and no smoking was allowed anywhere in the Museum Building. Students who did smoke habitually, however, sooner or later were made vividly aware of Dr. Thaxter's feelings in this matter. A lecture on the evils of tobacco to one such student whose excellent illustrations of entomogenous fungi have since aroused the admiration of mycologists, led as a sequel to one of the few times when Dr. Thaxter was ever actually taken aback. Late that afternoon, Dr. Thaxter, who was demonstrating a point in drawing to one of the neophytes, remarked, "Well, I do not know

what's the matter with me. My hand is not steady today," whereupon the student recently reproved, bending over his work in the far corner of the laboratory, remarked in a penetrating whisper, "nicotine!" at which Dr. Thaxter laid down the pen and without a word retired to his office.

He had a decided scorn for illogical forms of simplified spelling, as students submitting manuscripts to him speedily found out. He had little patience also with lack of conscientiousness in any form, whether in the careless, inaccurate illustrations that reflect inadequate observation and hasty execution, or in the vague writing whose lack of clarity in expression usually denotes lack of clarity in thought.

He was a member of Phi Beta Kappa, of the Botanical Society of America, the American Phytopathological Society, the Boston Society of Natural History, the American Philosophical Society, and the National Academy of Sciences, a fellow of the American Association for the Advancement of Science and of the American Academy of Arts and Sciences. His eminence was recognized formally by his colleagues and fellow botanists, as he was elected President of the New England Botanical Club, President of the American Mycological Society, and President of the Botanical Society of America. This recognition extended to Europe as well, for he was an honorary member of the Russian Mycological Society, the Linnean societies of London and of Lyons, the Royal Botanical Society of Belgium, the Royal Academies of Sweden and Denmark, the Botanical Society of Edinburgh, and the Academy of Science of the Institute of France, as well as the only American botanist of his time on whom honorary membership was conferred by the British Mycological Society and the Deutsche Botanische Gesellschaft. He was until his death the American editor of the *Annals of Botany*, being appointed in 1907 to succeed Dr. Farlow. For some of his early work on the Laboulbeniales he received the Prix Desmazières from the French Academy.

Less formal but even more widespread evidence of his eminence is found in the unusual reputation as a mycologist which he bore among botanists throughout the world. This was the result not only of his publications but also of the general recognition of his

extraordinary knowledge of the fungi among the great numbers of investigators who turned to him for help in puzzling questions as to the identification and nature of obscure and perplexing organisms. Workers not only in mycology but in many other branches of natural science sought the benefit of his knowledge and the amount of correspondence he carried on with those who consulted him during the last forty years seems appalling to us lesser men of the present, especially when we realize that the whole great bulk of his correspondence was carried on without the aid of any secretary or typist, most of it being written in his own hand, for he had a feeling that typewritten letters were in a sense too mechanistic and impersonal for most correspondence, the others being typewritten by himself on a small portable typewriter. That many botanists were aided by his expert knowledge and sound judgment in mycological matters is obvious from the voluminous correspondence that he has left. It is certain also that many were disconcerted through his uncanny familiarity with fungi which enabled him to identify as insect eggs the specimens they had sent as Myxomycetes, to set their minds at rest that their new genera of leafspotting fungi in reality were the adherent sporangia of *Pilobolus*, and to tell them in detail the structure, development, and relationship of "new" forms they had discovered from his own exacting work on these same forms twenty years before.

Many of Dr. Thaxter's letters were written to mycologists and other botanists, especially those who had just begun to publish, concerning their papers which Dr. Thaxter, having read with conscientious care, commented upon at length, encouraging or criticizing impartially and from his greater knowledge bringing out points of significance and interest untouched in the paper itself. Many a young investigator having published his first paper was cheered and heartened by this encouraging recognition from Dr. Thaxter, and many also were stimulated to more careful work and more painstaking illustration by his impersonal and just criticism.

Those of us who had the privilege of being associated with him could sense beneath his reserve and austerity a kindliness which revealed itself here and there in phrases in letters, in a

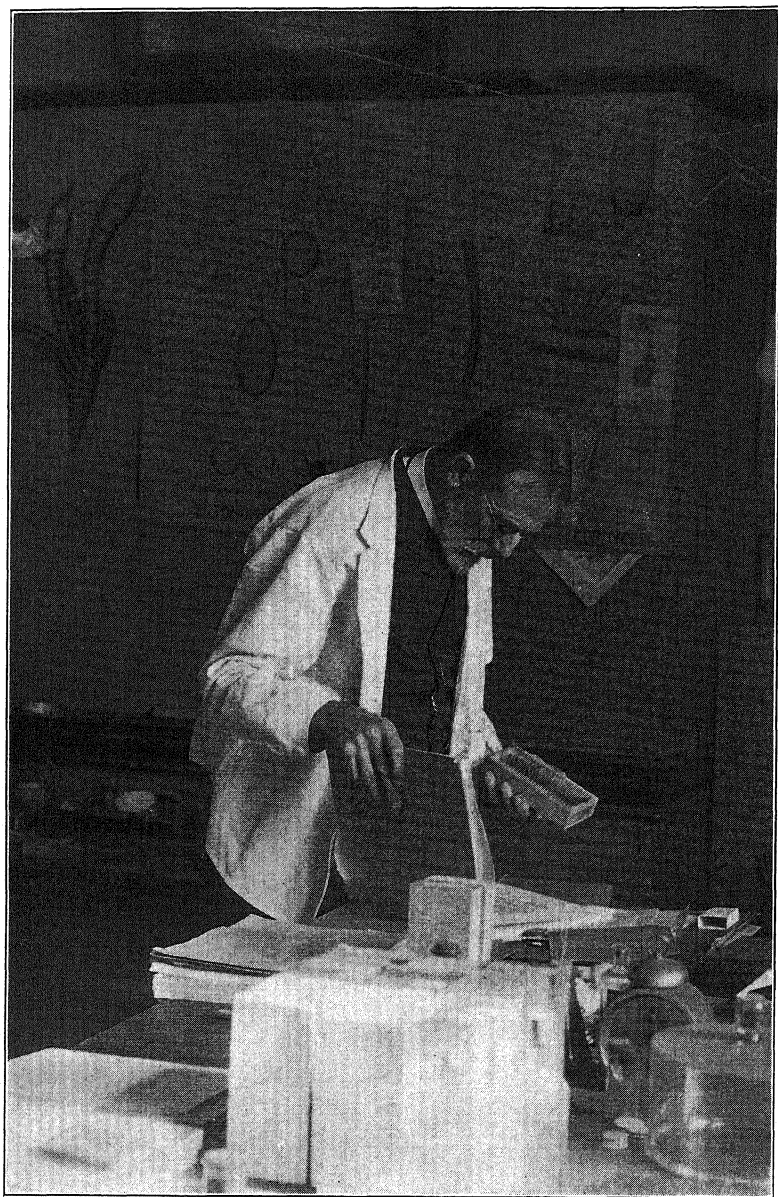
turn of conversation, in unexpected and much prized gifts, or in unexpected help through difficulties. To see the genial whimsicality that he showed toward the dog, Bobby, or toward the parakeet, Malatesta, or to watch the solicitous care with which he tended some of the rare and beautiful flowers that he grew in his garden and in the house with such success, was to glimpse another side of his character and to appreciate that he was a human and likable man as well as the greatest mycologist of his time.

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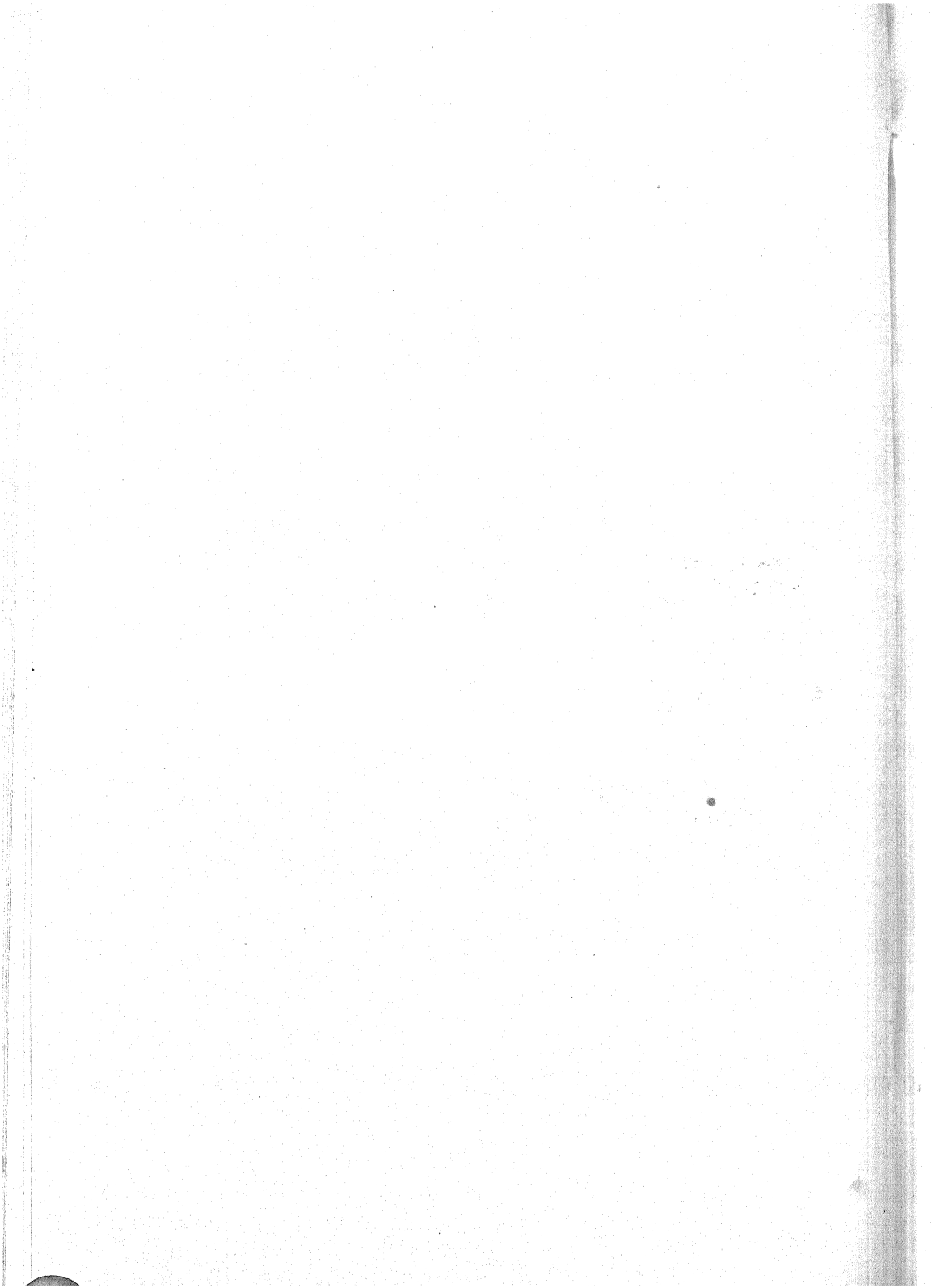
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THE PERITHECIUM AND ASCUS OF PENICILLIUM¹

B. O. DODGE

(WITH PLATES 18 AND 19 AND TWO TEXT FIGURES)

Brefeld² began studying the fungi at the time when the question of pleomorphism was exciting considerable interest among mycologists. *Penicillium* was the most common mold, and he determined to learn whether it was also, like *Aspergillus*, pleomorphic, having a sexual stage as well as the conidial stage which was familiar to every one. Brefeld was not satisfied to base his conclusions on cultures obtained by mass transfers of conidia. He adopted the new method of at least starting with single spore cultures. The great detail and beauty with which he described and figured the various steps in the development of the ascocarpic and conidial stages of his fungus were so convincing that his story of "*Penicillium glaucum*" became the favorite for illustrating the life history of ascomycetes.

One might well question whether Brefeld in identifying his fungus as *Penicillium glaucum* had the fungus described by Link. Furthermore, no one today, according to Thom,³ seems to know exactly what fungus Brefeld himself had. It would serve to clarify the situation, however, if we could compare the stages in growth observed by Brefeld with what we would find in studying a species that has the same kind of ascocarp. Such a species has been found recently, and, in following its growth in culture, one realizes, if he makes due allowance for the state of mycological knowledge in Brefeld's time, how beautifully he illustrated the developmental features as he understood them.

Dr. Rhoda Benham of the Department of Dermatology, Col-

¹ Presented at the first meeting of the Mycological Society of America held in Atlantic City December 28-30, 1932.

² Brefeld, O. Botanische Untersuchungen über Schimmelpilze. II. Die Entwicklungsgeschichte von *Penicillium*. 1-98, 1874.

³ Thom, C. The Penicillia. 1-644. Baltimore. 1930.

lege of Physicians and Surgeons, has recently been making a study of the fungi found inhabiting the skin and alimentary canal of 100 young men and women. She was particularly interested in species of *Cryptococcus* and other yeast-like forms related to *Monilia albicans*. She will report on her work later. While making this survey she also obtained cultures representing dermatophytes and other species of fungi, most of the latter being saprophytes. We are indebted to her for several hundred such cultures and to Dr. C. W. Emmons for some stained sections of perithecia which were turned over to the writer for study and for exhibits at The New York Botanical Garden. One culture, Ed 24, proved to be a species of *Penicillium* which was producing perithecia abundantly. No similar species is mentioned by Thom³ but upon examining our cultures Dr. Thom suggested to the writer that the fungus was near *P. javanicum* van Beijma, probably a variety of that species. If one grows the strain representing van Beijma's fungus obtained from Dr. Thom along with our Ed 24 strain he has no difficulty in distinguishing the two forms regardless of what culture medium is used. If he were to rely on van Beijma's description and figures he would certainly separate the two forms specifically. For example, she says the asci are 4-6-spored. Ours are 8-spored. Her cultures are dark-orange and the perithecia are orange-colored. No such yellow or orange colors are shown by our Ed 24. The asci and ascospores are noticeably smaller than ours, although the extreme measurements given are about the same. Any one can distinguish the two species by comparing mounts. The asci of *P. javanicum* average about two or three microns smaller than ours. The ascospores average at least a micron smaller. In other morphological features of the ascocarpic stage they are very much alike. Some may prefer to consider them merely as varieties of a collective species. This would require either varietal names or some designating numbers, but would be fully justified if, by starting with single ascospore cultures of one variety one could obtain a form morphologically and culturally indistinguishable from the other variety and vice versa. What would happen if the same method of study of the ascocarpic stage were applied to the several hundred other species of *Penicillium* created on the basis of their conidial stage alone, would be interesting to see.

Penicillium Brefeldianum sp. nov.

Mycelium and conidial masses variously colored depending first on the particular race and second on the nature of the culture medium, whitish, cream, peach, fawn, mouse or grayish to pale green; on corn meal agar sparse with few conidia; homothallic.

Conidia spherical to short elliptical smooth, $1.5-2 \times 2-3 \mu$; penicillus commonly monoverticillate; sterigmata $2.5-3 \times 7-10 \mu$, the spore-forming tube prominent; conidiophore short, slightly enlarged at the tip, side branches rather frequent, $3-4 \times 5-150 \mu$.

Ascocarps spherical, whitish to pale tan, non-ostiolate, superficial, growing upon, and more or less surrounded by, a loose web or network of hyphal branches, $100-200 \mu$ in diameter, mostly about 150μ ; asci oval, pear-shaped to spherical, $7.5-12 \times 10-15 \mu$, 8-spored; ascospores globose to slightly elliptical, hyaline, finely echinulate, $2.5-3.8 \times 3-4 \mu$.

Isolated from alimentary tract of human.

Culture deposited in the Herbarium of The New York Botanical Garden.

Conidia e sphaericis breviter elliptica, laevia, $1.5-2 \times 2-3 \mu$; penicillus univerticillatus; sterigmata $2.5-3 \times 7-10 \mu$; conidiophorus asymmetricus, ramis lateralibus non nullis, $3.5-4 \times 5-150 \mu$.

Perithecia sphaerica, albida vel pallide brunnea, exteriora, $100-200 \mu$; asci ex ovalibus sphaerici, $7.5-12 \times 10-15 \mu$, 8-spore; ascospore e globosis subellipticae, hyalinae, minute echinulae, $2.5-3.8 \times 3-4 \mu$.

Brefeld worked merely with clean cultures and he could not have carried his single spore culture pure long enough to show all of the stages in the life cycle from ascospore to ascospore. He thought that for the maturing of the ascospores it was necessary to grow the fungus finally on bread in dark cool places shut off from the air. Therefore, he would carry his cultures several weeks to the sclerotial stage and then sow the sclerotia on thin slices of bread pressed between glass plates to exclude the air. Brefeld has pointed out how nearly the ascospore, which he figures with a furrow running around the equatorial region, resembles ascospores of *Eurotium* (*Aspergillus*). It was by the germination of these ascospores, however, and the formation of *Penicillium* conidiophores directly connected with the ascospore

germ tubes that convinced Brefeld that he had followed out the life history of his *Penicillium*.

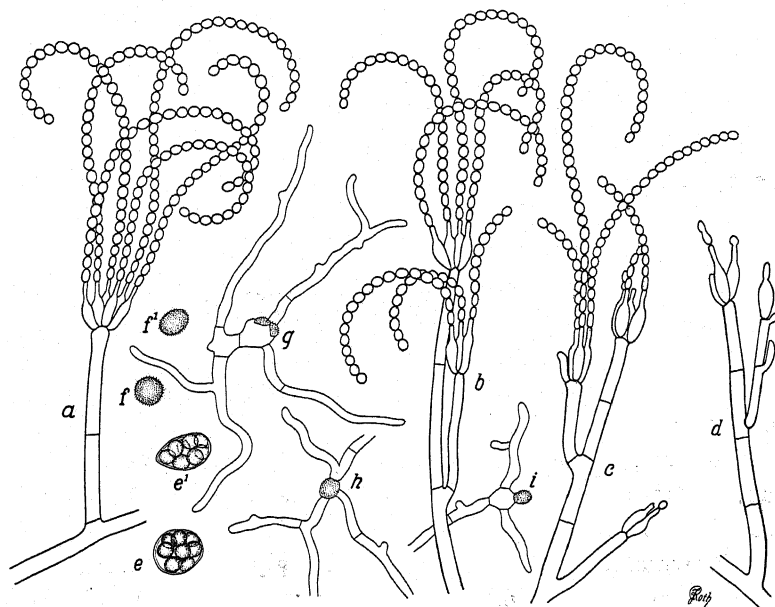


FIG. 1. *Penicillium Brefeldianum*. a-d, various stages in the development of the conidial stage; e, e', spherical and oval asci; f, f', spherical and elliptical ascospores; g-i, three types of ascospore germination, g showing fragments of the spore-wall clinging to the germ vesicle as figured by Brefeld.

SINGLE SPORE CULTURES

From Dr. Benham's culture, Ed 24, twelve single conidium cultures were isolated and grown on corn meal agar. In every case ascocarps began to appear after about two days. Asci began to form by the end of seven days and ascospores were visible within ten days from the time the cultures were started. In not all cases, however, do the ascocarps mature in such a short time. This will depend upon the conditions of the medium and the temperature of the room.

Ten single ascospore cultures were also isolated. Germination was abundant after about ten hours. Two or three germ tubes are formed. If the ascospores are young they germinate without much swelling, pushing out germ tubes directly (FIG. 1, h); or

the spore contents may move out as a vesicle from which the germ tubes then emerge (FIG. 1, i) as in *Neurospora*. After the spore becomes fully matured with a thickened wall, it may swell to about twice its original size on germinating, bursting the wall into two parts which cling to the spore (FIG. 1, g) much as is shown by Brefeld in his plates 7 and 8. There is no suggestion of a furrow, however, running around the spore, and the two parts into which the spore wall is usually broken up do not represent or resemble two halves or equal valve parts of a spore wall as is the case in *Aspergillus*.

Culturing *P. Brefeldianum* on agar plates, very definite examples of sectoring were met with. A less pronounced illustration of this is shown incidentally in plate 18, d. Several series of transfers were made from snow-white sectors with few conidia, from fawn-colored sectors, and from pale greenish sectors with many conidia. Very different pictures were presented by the three sets of cultures, each grown separately on Czapek, Sabouraud, dextrose, and potato dextrose agars. On corn meal agar these differences were not so noticeable. The van Beijma strain, when grown on corn meal agar, was strikingly different from any of our strains. Certain of our races produced a greater abundance of conidia and ascocarps. Other races produced many conidia but very few ascocarps. Corn meal agar is the most suitable for the study of ascocarps because of the sparseness of mycelial hyphae and conidia (PLATE 18, a). Other media may produce more ascocarps than appear on corn meal agar, but there is usually in such cases an excessive surface growth (PLATE 18, b-d) in which the ascocarps become imbedded.

On corn meal agar the conidiophores are not at all fasciculate and no coremia have ever appeared on any of the different media. What would happen at low temperatures was not determined. The conidial stage (FIG. 1, a-d) may belong to Thom's asymmetric group. It is certainly not a biverticillate species and it can not belong to the *P. luteum* group, although on Czapek's medium yellow droplets appear over the surface of the culture (PLATE 18, d).

ORIGIN OF THE ASCOCARP

Brefeld's figures of two short bodies, arising from adjacent cells, and coiling spirally about each other as the beginning of the

perithecium are familiar to all botanists. If these coiled organs are the very first indication of where an ascocarp is to arise, then our species is different from the one he worked with. In our fungus one sees first a very short branch arising vertically from an ordinary mycelial hypha at the surface of the medium. This stalk forks, giving rise to two or three primary branches which in turn put out rather stiff secondary branches at broad angles (FIG. 2, a), giving a miniature picture of a small defoliated fruit tree. There is absolutely nothing resembling sex organs or ascogonial coils at this stage. Later on, however, there appear in the crotch or fork of the system rather thick structures irregularly wound or clumped in a loose knot, and which stain more deeply with aceto-carmin. This may be the point at which Brefeld began his study as he says that the coiled bodies arise from a rather thick much jointed mycelial hypha. Crushed mounts stained with aceto-carmin do show such "jointed hyphae" at this stage, but I have not made out the pair of coiled structures figured by Brefeld.

In the Ascobolaceae, Sordariaceae and *Pyronema* one sees first of all the sex organs. There is at least an ascogonium present at the beginning. In *Penicillium Brefeldianum* it is the little hyphal tuft which first appears, and on, or within, which the stromatic as well as the ascogenous elements of the ascocarp arise. It continues to branch loosely growing up around the young perithecium (FIG. 2, b) remaining attached to the base of, but never becoming actually incorporated with, the fruit body as a part of the wall. By compacting its web of branches in cutting sections by hand one might be misled into thinking that there was a loose outer wall to the perithecium that sloughed off, as figured by Brefeld for his fungus, although he says he was not certain as to the origin and function of this outer web. One sees the exact relationship if he removes a perithecium, placing it in a drop of aceto-carmin or any mounting fluid. The loose network can be removed with a pair of fine needles. It represents the original subicular tuft which is still firmly attached to the base of the fruit body. Most of the nourishment for the growing perithecium must come up through the original stalk cells. In *Aspergillus* this single hyphal stalk often supports the

perithecium. In our *Penicillium* the perithecium settles down on the agar so that branches of the hyphal tuft may adhere to the basal part. The tangle of free ends forms a fuzzy complex of protecting hyphae. Crushed mounts always show a few scattering brownish amber-colored hyphae adhering closely to the wall of the perithecium. Sections (PLATE 19) do not show that these peculiar cells grow out into the air as a fringe. The end branches of the hyphae composing the fuzzy and rather more compact tuft in the van Beijma strain are always covered with a thick amber-colored crystalline deposit, very noticeable when grown on corn meal agar. These are absent in case of our strain Ed 24.

THE ASCOCARP

During the first seven or eight weeks in cultures on bread, Brefeld's *Penicillium* developed little sclerotia with the three or four outer layers of cells thickened and hardened. They looked like little yellowish grains of sand. After their resting period, they could be induced to develop into perithecia by sowing them again on sheets of bread placed between glass plates. The ascogenous hyphae which had been growing slowly during the first period now increased in length at the expense of the inner tissue of the sclerotium. He saw three kinds of hyphal elements. First, the large septate hyphae; second, the true ascogenous hyphae with peculiar short branches with recurved tips; and third, the very thin hyphae which he said must function to disorganize the inner tissues of the sclerotium to obtain nourishment for the asci. It sometimes required several months to complete the life cycle.

In our cultures of *Penicillium Brefeldianum* on corn meal agar no resting sclerotial stage has so far been observed. Such bodies might develop if certain races were grown on less favorable media. The ascocarp grows on rapidly from the beginning, forming a solid mass of pseudoparenchymatous tissue with little or no differentiation except for the somewhat thicker walls of the cells of the outer layer. At the center will always be found the ascogenous system much as described by Brefeld. The fruit body at no stage is "hard and stony like a grain of yellow sand" although sections (PLATE 18, f) often suggest sclerotoid tissue, and no

doubt unfavorable media might result in throwing the young perithecium into a resting condition where it would become sclerotized. The young perithecia of *P. javanicum* are somewhat tougher than are ours, and tend more to resemble sclerotia by their hardness. Some sections of *P. Brefeldianum* show compact perfectly normal thin-walled cells composing the pseudoparenchymatous stromatic tissue (PLATE 19, b). In every case the ascogenous system occupies the central region of the fruit body, gradually providing a cavity by disorganization processes. Brefeld's description of the growth of the ascogenous system in his species is very complete, and would, except as to the method of the origin of the asci, apply, for the most part, to *P. Brefeldianum*. The older the ascocarp under good growing conditions the larger the cavity and the greater the number of asci with a corresponding thinning out of the sterile wall layers.

FORMATION OF THE ASCUS

The idea is prevalent that the asci of *Penicillium* always arise along curved tubular non-septate hyphae by series of swellings and partial constrictions, so that even when mature no cross walls separate adjacent asci. The method of formation of asci in chains like monilioid conidia or the budding out of one ascus directly to form another would be entirely different from that known for higher ascomycetes. I have, therefore, given this question particular attention and have found the idea quite erroneous.

Just as Brefeld describes so well there are three kinds of hyphae occupying the central region of the young ascocarp of *P. Brefeldianum*. First, there are rather large hyphae with blocky cells with little granular contents. These seldom branch and are not much curled or contorted. They represent ascogonia, perhaps, in function. Second, from hyphae of the first sort arise the more deeply staining primary ascogenous hyphae with granular contents. These are more twisted and irregular in form. Septation is frequent though not always easily made out. Short thick branches, often divided and recurved at the tips, arise at intervals. Third, one sees the system of thinner hyphal threads. These would be Brefeld's digesting hyphae, though to assume that this is their sole function would be erroneous, as will be noted below.

The first asci arise as short side or terminal swellings from the thick primary ascogenous hyphae (FIG. 2, c-g). A septum soon cuts off the young ascus from its stalk or from the protuberance extending from the cell giving rise to the ascus. One after another the cells along an ascogenous hypha bud out to form a branch or an ascus (FIG. 2, d, f). This method of origin is readily made out by crushing perithecia from cultures of *P. javanicum*. Van Beijma⁴ was the first to notice this for she says that when one crushes a perithecium the fertile hyphae with asci budding from both sides are pressed out as a skein. If the culture is old and rather dried out prematurely, one sees asci carrying short stalk fragments floating around everywhere, proving further that in *P. Brefeldianum* and closely related forms like *P. javanicum* asci are not commonly borne in monilioid chains. On one or two occasions, however, it was possible to demonstrate very clearly that the adjacent cells of an ascogenous hypha from young ascocarps had rounded up to become asci directly (FIG. 2, h). One often sees in crushed mounts what at first appears to be a few asci in a chain, but by tapping the cover glass, the cluster turns over and it becomes clear that the asci are all borne on short outgrowths from adjacent cells. Preliminary studies of *P. bacillosporium* having the type of perithecium characteristic more of *P. luteum* show, however, that there are species where many of the first formed asci arise from very short twisted chains of cells much as Brefeld figures. A proliferating crosier system here is not an impossibility. As the cavity in the perithecium of *P. Brefeldianum* increases in size the ascogenous system consists more and more of the very thin hyphae growing around irregularly in all directions. They certainly bear asci very frequently (FIG. 2, i).

Emmons⁵ has recently proved that in *Thielavia Sepedonium* each cell of the large ascogenous hyphae is uninucleate. This nucleus divides, one daughter remaining behind, the other moving out into a side bud which becomes an ascus directly. The young-

⁴ Van Beijma Thoe Kingma, F. H. Mykologische Untersuchungen—*Penicillium javanicum* nov. spec. Ver. Kon. Akad. Wet. Amsterdam 26: 16-19. 1929.

⁵ Emmons, C. W. The development of the ascocarp in two species of *Thielavia*. Bull. Torrey Club 59: 415-422. 1932.

est asci are found at the outer end of each branch of the ascogenous system. There is no crosier, no conjugate division of nuclei, and no nuclear fusion in the young ascus. There is no reason why any ascogenous cell should not be transformed directly into an ascus. Under the unfavorable conditions for continued growth such as probably existed in Brefeld's cultures of *Penicillium*, excluded from air as they were, the ascogenous cells might very well have become asci directly on occasion. As to the very fine system of branches found in the interior of the ascocarp of *P. Brefeldianum* it is certain that asci can arise from the ends of their branches as noted previously (FIG. 2, i). One finds mature

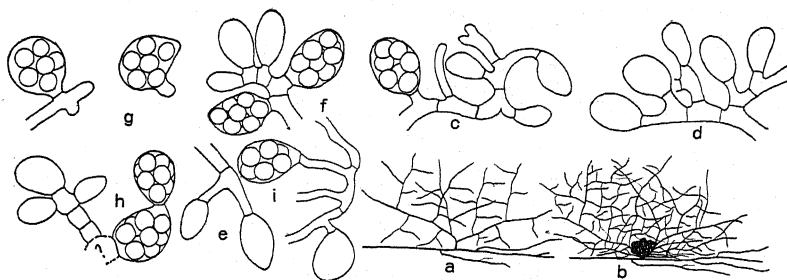


FIG. 2. *Penicillium Brefeldianum*. a, characteristic tree-like branching of the primordial hypha, a sort of subiculum, from which is to arise the perithecium; b, young perithecium, sterile and fertile elements intertwined, the original sterile branched system more highly developed and loosely surrounding the young ascocarp; c-f, various stages in the development of asci from side buds of the cells of the ascogenous hyphae; g, two asci characteristic of those seen in crushed mounts from a mature ascocarp; h, asci in a short chain suggesting that individual ascogenous cells may occasionally be transformed into asci; i, asci produced on the very fine secondary hyphae such as Brefeld considered merely digestive hyphae.

as well as immature asci crowded up against the tissue lining the cavity (PLATE 19, a). The fine hyphae probably take no greater part in the digestion of the stromatic tissue than do the other elements occupying the cavity. The stromatic cells are disorganized by enzymic action rather than by mechanical pressure exerted by hyphal growth. Asci get their nourishing directly by absorption from the surroundings, and not necessarily at all from the supporting ascogenous cell as suggested by Brefeld.

ASCOSPORES

As noted previously the ascospores of *P. Brefeldianum* are spherical to slightly elliptical, and finely echinulate. Van Beijma says that the ascospores of *P. javanicum* are spherical or irregular in form more or less 3-cornered. This difference may be due merely to the action of the mounting fluids used. There is certainly no band running around the spore such as Brefeld showed, and such as characterizes spores of certain species of *Aspergillus*. The fact that when a mature ascospore of *P. Brefeldianum* is germinated the spore wall usually cracks off, remaining in two fragments attached to the swollen spore, would suggest a close relationship to Brefeld's species, and under careful manipulation traces of such valve parts on an ungerminated spore perhaps could be made out even in our strain.

CONCLUDING REMARKS

In *Pleospora* the ascocarp is initiated by the parenchymatous division of some ordinary hyphal cell. There are no ascogonial coils or sex organs. The full grown ascocarp body is merely a differentiated stroma within which certain cells begin to disorganize to make room for the growth of other cells which will give rise to the ascogenous system. The important difference here between the young fruit bodies of *Pleospora* and *Penicillium Brefeldianum* is that in the latter the fertile ascogenous tissue is present from the first, burrowing about in, or enclosed by, the sterile stromatic tissue. Both kinds of tissue are continually increasing in amount as the ascocarp increases in size.

We have in the Plectascales various amounts of sterile protecting tissue in the mature fruit body. Only a very few species of *Penicillium* have been connected with ascocarpic stages. The perithecia of members of the *P. luteum* group (*P. Wortmanni*, *P. aureum*, *P. Sacchari* and *P. Petchii*) all have the most delicate surrounding periderm consisting principally of a loose web of interlacing hyphal branches. Such a covering might well be represented in *P. javanicum* and *P. Brefeldianum* by the tangle of branches which supports and surrounds, but is not an integral part of, the ascocarp. *P. Wortmanni* in its simplest races is merely a good *Gymnoascus*. The perithecia of *P. bacillosporum*

and of *P. spiculisporum*, on the other hand, have a well organized wall of compacted hyphal branches but the perithecial cavity is apparently formed entirely as the result of excessive peripheral growth of the hyphae surrounding the ascogenous elements. The perithecium of *P. avellaneum* is bounded by a peridial wall consisting of a single layer of highly differentiated cells. A third type of perithecium and still more advanced, is found in *P. Brefeldianum*, *P. javanicum* and *P. glaucum* of Brefeld, where the central cavity is hollowed out of a rather solid pseudoparenchyma stromatic tissue through digestion brought on in connection with ascogenous growth. The older the fruit body the larger the cavity and the thinner the stromatic wall layers (PLATE 19, b). It starts out to be of the *Gymnoascus* and *P. Wortmannii* type as is shown by the tangle of hyphal branches loosely gathered around the ascocarp, and which in Brefeld's form and the van Beijma race, is quite compact. We get from this some idea of how the Gymnoascaceae (if such there are distinct from the *Penicillium luteum* sort) evolved into species like *P. Brefeldianum*, *P. javanicum* and *P. glaucum*. From this to *Microascus* (*Scopulariopsis*) with an ostiole is not a big step if one goes by way of *Thielavia Sepedonium*, where the conidial stage shows a *Penicillium* ancestry just as *Scopulariopsis* does.

With the discovery by Sopp,⁶ Curzi,⁷ and Emmons and Dodge,⁸ that certain species of *Scopulariopsis* have a *Microascus* perithecial stage, the theory that such species are not true *Penicillia*, finds further support. The ascocarps are dark colored or carbonaceous and distinctly ostiolate. Ascospores are discharged in long cirrhi. The growth of the ascogenous hyphae outward and downward from a centrally placed ascogonium shows, however, a relationship to *Penicillium* and the other "Plectascales."

It is necessary in identifying a species of *Penicillium* from its conidial stage to grow the fungus on some standard medium where the color changes can be followed, and certain peculiarities

⁶Sopp, O. J. Monographie der Pilzgruppe *Penicillium* mit besonderer Berücksichtigung der in Norwegen gefundenen Arten. Skr. Vid-Selsk. Kristiania 1912: Mat.-Nat. Kl. 1: 1-208. 1912.

⁷Curzi, M. Una nuova specie di *Microascus*. Boll. Staz. Pat. Veg. 10: 302-310. 1931.

⁸Emmons, C. W. & Dodge, B. O. The ascocarpic stage of species of *Scopulariopsis*. Mycologia 23: 313-331. 1931.

in the manner of growth of the mycelial hyphae and the conidial system can be studied carefully. We may therefore conclude that, so far as Brefeld's account of the conidial stage goes, his *P. glaucum* and our *P. Brefeldianum* may or may not be identical. But when we compare the diagnostic features of the ascocarpic stage we see first that his ascocarps were much larger 800–1000 μ , while ours seldom exceed 200 μ . His ascospores were possibly a little larger, $3 \times 5 \mu$, and showed two valve parts like an *Aspergillus* ascospore, while ours are $2.5\text{--}3 \times 3\text{--}4 \mu$, mostly spherical, finely echinulate, but have no other wall marking that can be made out readily. This one feature alone would serve to distinguish the two species. The methods of the origin of the asci in the two species are also different, but when one reads Brefeld's account carefully and everything is considered and due allowance made, perhaps not so radically different. As a rule asci of *P. Brefeldianum* are borne as side or terminal buds from the ascogenous cells. Brefeld figures a single ascus on a short stalk in his plate 6, fig. 36, a. He would, however, say that such a cell would ordinarily bud out to form another ascus. When asci are occasionally formed in a short chain their contents are never in open connection as figured by Brefeld in his plate 6, figs. 36, 38, 39. It is the individual cells of a fertile hypha that then become asci directly, and the adjacent asci must obviously be already separated by a septum. Brefeld does not say that the septum is put in between two asci after they are differentiated as such, and have ascospores. One ascus does not bud out like a yeast cell to form another after spores are delimited.

Knowledge of ascus formation in other groups was not extensive in Brefeld's time and his idea of ascus formation in *Penicillium* was a matter of interpretation of what he saw in his mounts, which, he continually reminds us, showed such a tangle that he was forced to write some of the story without being quite sure of what was going on. This will in no way detract from the great value of his many accurate observations and his beautiful drawings which will stand for all time as models and be an inspiration to students of the fungi. It is interesting to learn that there are certain species in which most of the asci are formed in chains, while in other species the asci are commonly formed on short stalks or buds much as they are in *Thielavia Sepedonium*.

SUMMARY

The conidial stage of *Penicillium Brefeldianum* belongs to the monoverticillate group. The species is homothallic, producing its ascocarps readily in culture. Fertile as well as sterile elements of the fruit body arise in the fork of a special tree-like hyphal complex, which is the first set of elements concerned with ascocarp formation. Ascogonia, paired spirally coiled bodies, or sex organs, if any such develop, must come second. The mature ascocarp remains attached to this primary network and through its stalk derives nourishment from the mycelial hyphae in the medium. The young perithecium is composed largely of a stromatic pseudoparenchyma tissue showing little differentiation. At the center ascogenous elements increase in extent at the expense of the stroma. Under good culture conditions the asci mature within two weeks after sowing the spores. There is no hard sand-like sclerotial resting stage.

The ascus usually arises as a side or terminal bud from a cell of an ascogenous branch. A septum cuts off the ascus from the stalk, or the cell from which it arises as a bud. Rarely are asci of *P. Brefeldianum* and *P. javanicum* found in a chain. This has been found to be more common in certain other species. In this case the fertile cells instead of sending out side buds or branches, would become transformed into asci directly. The idea that the asci are formed as swellings along the course of a non-septate hypha, the adjacent asci being connected by isthmuses and not separated until later, if at all, by cross walls, is a misconception due largely to a misunderstanding of Brefeld's account. His figures of ascus formation are perhaps misleading in that they frequently show asci in open connection. Such a method would certainly be anomalous among the Ascomycetes, but in the absence of crosiers there is no reason why adjacent cells of the ascogenous hyphae may not become asci directly as frequently occurs in certain species.

This study of *P. javanicum*, and *P. Brefeldianum* as represented by our cultures Ed 24, proves that there is a group of species of *Penicillium* having a perithecium comparable to that of *P. glaucum* of Brefeld. These ascocarps, while lacking the dark-colored carbonaceous wall of *Thielavia*, are nevertheless much the same

in their organization. The perithecia of species belonging to the *P. luteum* group are very different, lacking entirely the so-called "sclerotium" complex, which is merely a stromatic tissue within which fertile elements are continually developing.

THE NEW YORK BOTANICAL GARDEN
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EXPLANATION OF PLATES

Penicillium Brefeldianum

PLATE 18

a-d. Cultures on four different kinds of agar media; a, corn meal; b, potato-dextrose; c, dextrose; d, Czapek's medium. The numerous small whitish bodies shown especially in picture a are perithecia. Those at the center contained hundreds of mature asci. Cultures all 17 days old. Somewhat reduced in reproduction.

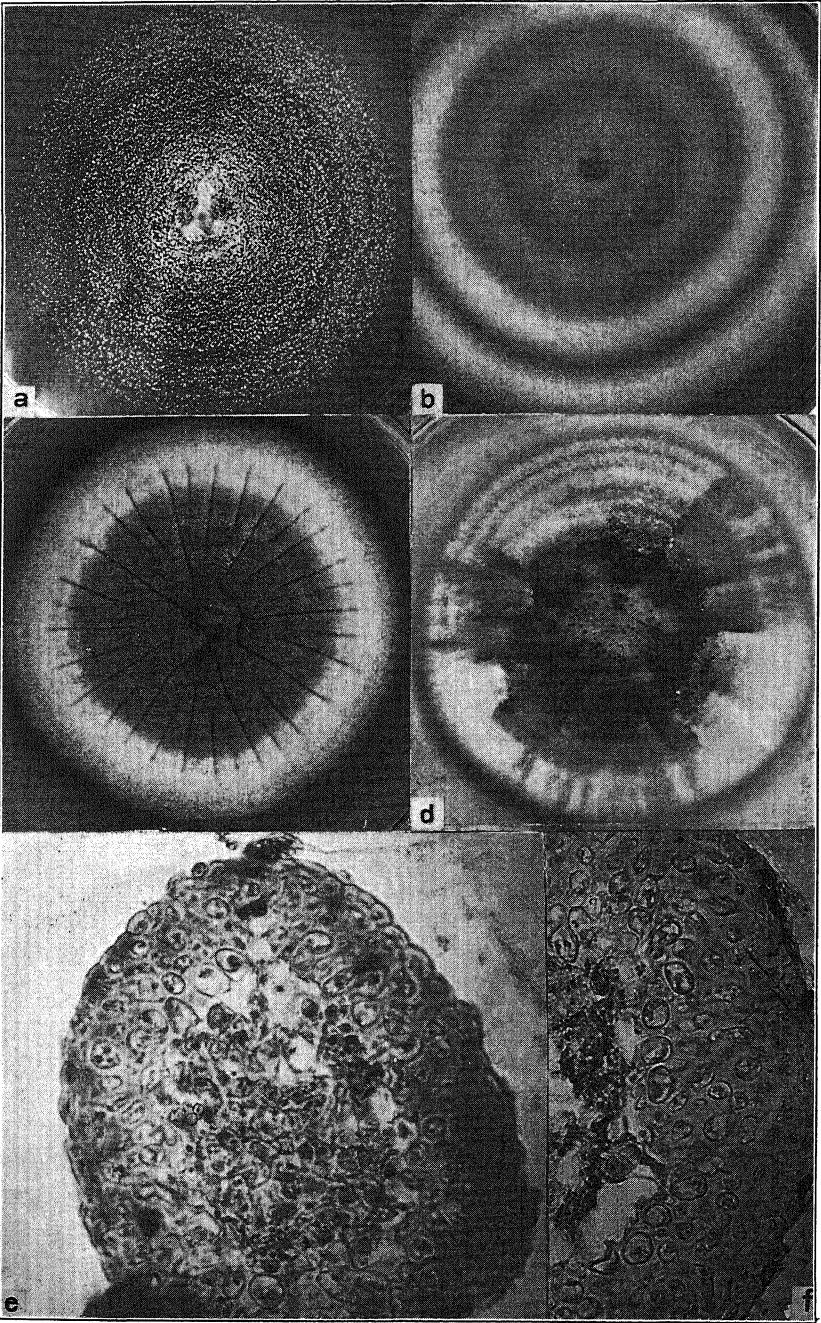
e. Section through the equatorial region of a young ascocarp showing the central mass of ascogenous hyphae and young asci.

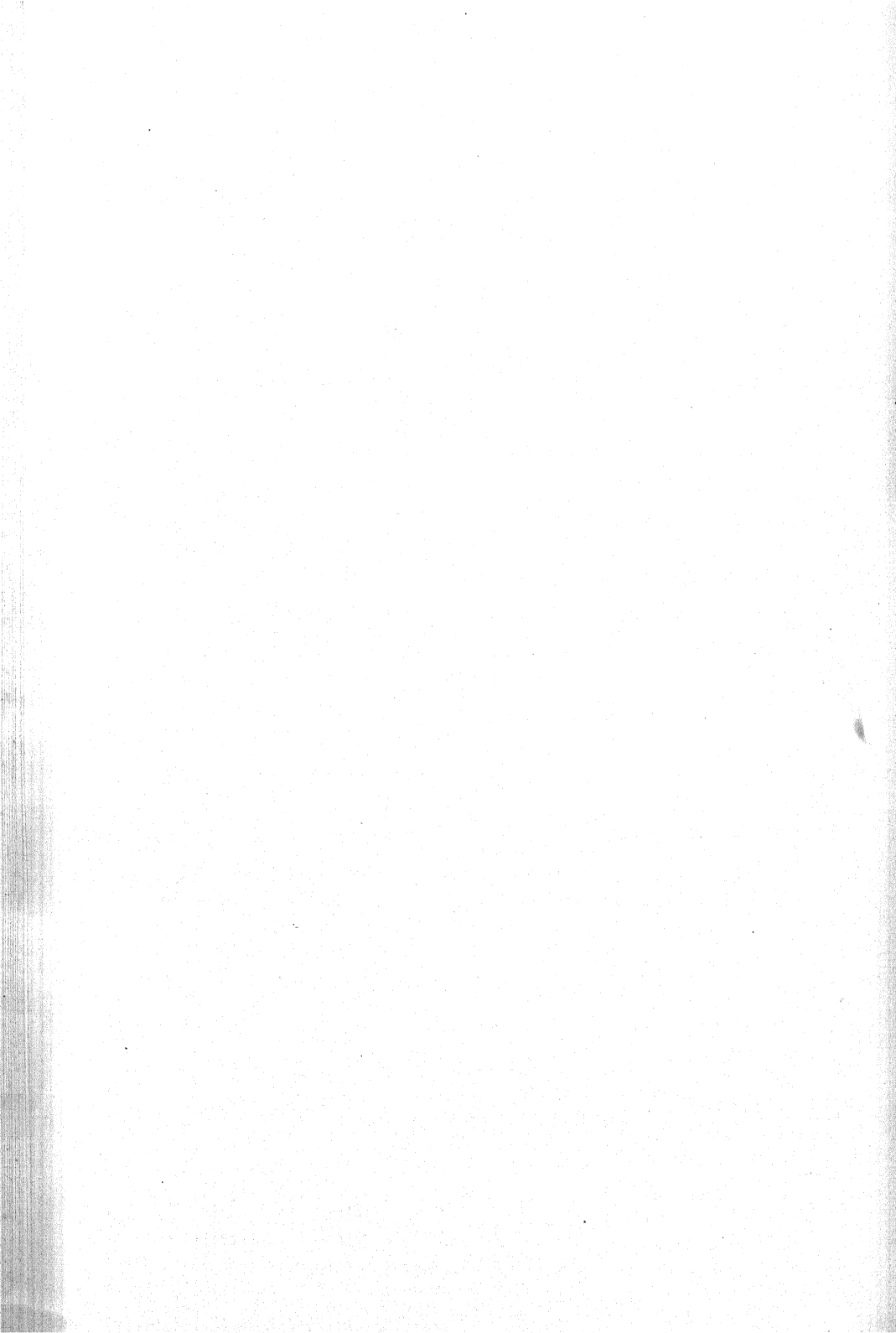
f. Portion of a section of a young ascocarp showing the nature of the pseudoparenchymatous sterile stromatic and peridial wall tissues.

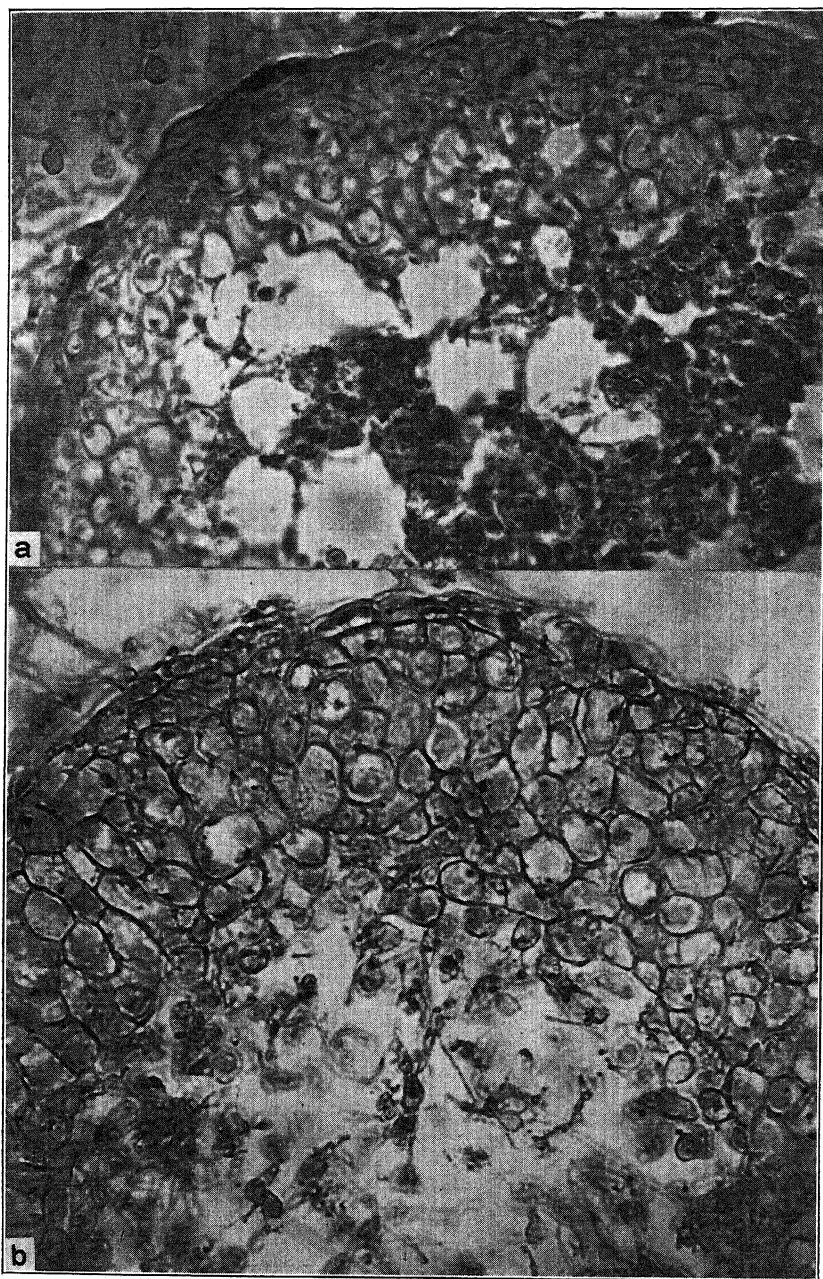
PLATE 19

a. Part of section of a mature perithecium showing disorganization of sterile tissue and mature asci.

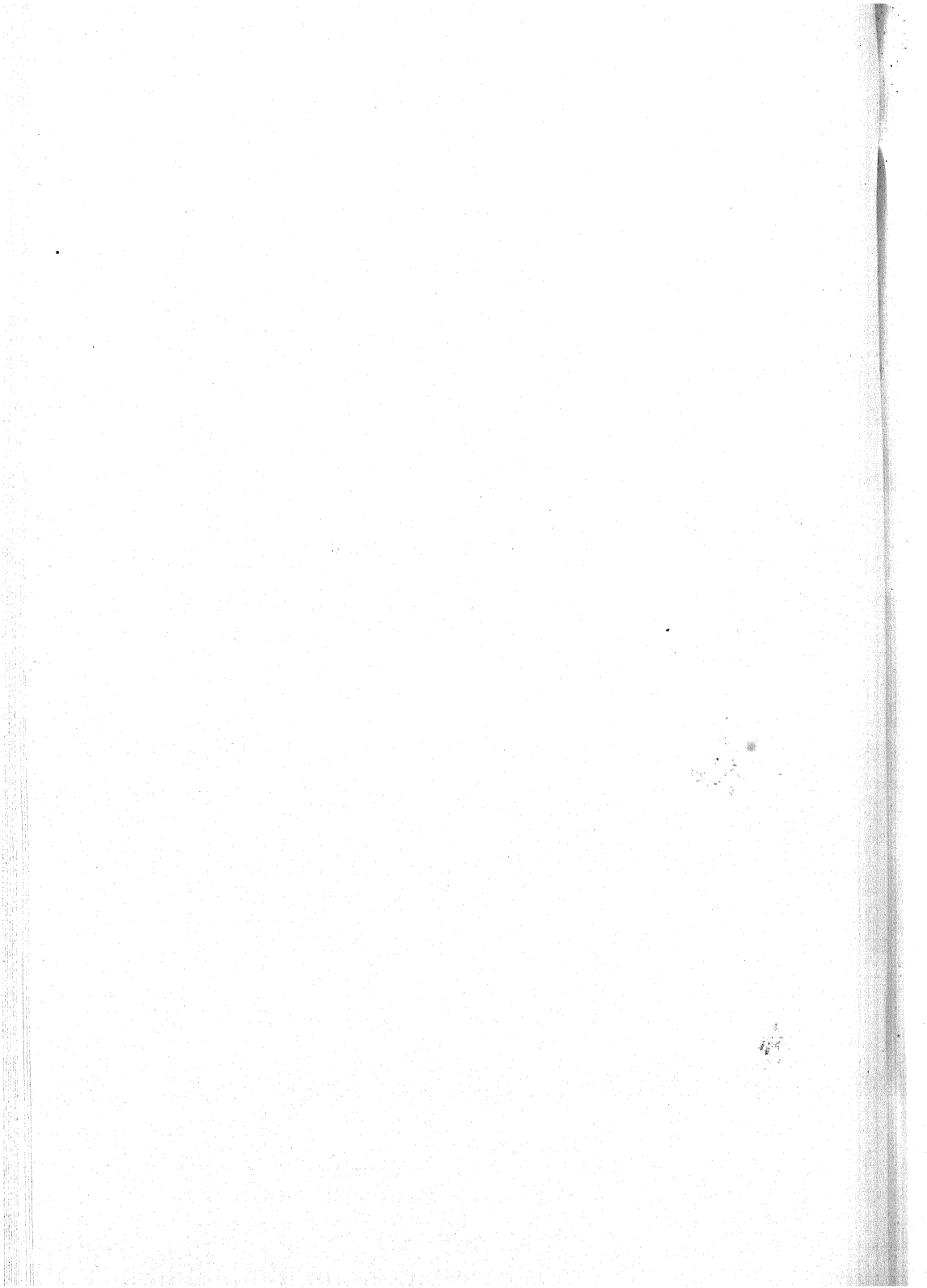
f. Perithecium from same culture as a. No suggestion of sclerotized tissue; cavity well formed. Compare with plate 18, f, as to the difference in the appearance of the cells of the sterile tissue.







PENICILLIUM *BREFELDIANUM*



TREMELLA GANGLIFORMIS, A NEW AND UNIQUE TREMELLACEOUS FUNGUS¹

DAVID H. LINDER

(WITH 1 TEXT FIGURE)

While collecting fungi in Missouri during the early springs of 1930 and 1931, the writer encountered on decaying wood a fungus which because of its small size and its gelatinous texture appeared to be a member of the Tuberculariaceae of the Fungi Imperfecti. When examined under the microscope, however, the specimen proved to be not an imperfect fungus, but a member of the Tremellaceae.

The fungus grows on the under side of very wet decaying wood of a prostrate elm tree. With an excess of water, the fungus appeared to form colonies of many white pustules, but as soon as the excess of water evaporates, the pustules, under a hand lens, can be seen to be connected by strands, of various shapes and sizes, which run over the surface of the substratum, and do not as in most other members of this group, break through the surface of the substratum in more or less irregular lines that follow the grain of the wood. Some of the connecting strands are almost flat and of equal width throughout their length, but the majority are more or less rounded and with occasional swellings and hence resemble the ganglia of certain of the invertebrates. However, the resemblance ends at this point since instead of being relatively straight and unbranched, the chain of gelatinous pustules may turn nearly at right angles, and also frequently is branched, in which case the diverging strands appear to have their origin from the base of a swollen portion of the strand or from a pustule (FIG. 1). If the thinnest strands be studied under the low power of a compound microscope, it can be seen that there is a general parallel arrangement of the elements, which however, because of their small diameter, can not

¹ Contribution from the Cryptogamic Laboratories at Harvard University no. 115.

be clearly discerned. In the thicker strands the parallel arrangement is obscured by the hyphae which have arisen by branching from the horizontal elements.

When a pustule is mounted in lactophenol-cotton blue and carefully crushed under a cover glass, it is difficult to find the hyphal elements of the original strand since they appear to lose the greater part of the protoplasmic content by the time that the pustules are well formed. There are, however, a few hyphae

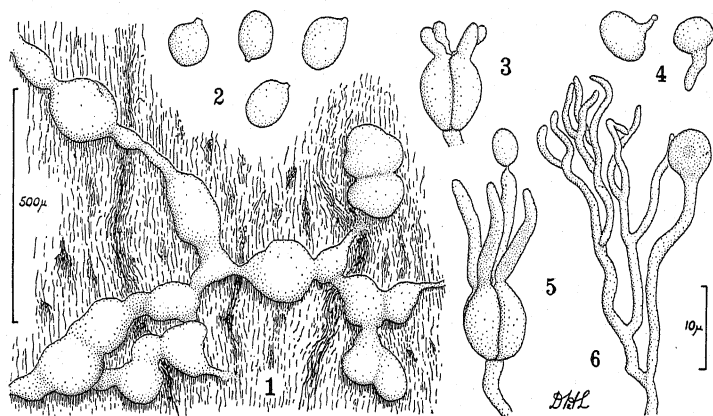


FIG. 1. 1. Habit drawing of the fruiting bodies to show the strands connecting the pustules. 2. Basidiospores. 3. Young basidium with developing sterigmata. 4. Germinating basidiospores. 5. Mature basidium. 6. Very young basidium with a single large fusion nucleus, and the paraphysoid sterile hairs.—All drawings made with a camera lucida, figure 1 to the scale shown at the left, the remainder to the scale at the right.

which run parallel with the substratum and from these arise the slender (less than $1\ \mu$ in diameter), much branched and vacuolate hyphae that do not stain readily. These hyphae, rather closely associated, are imbedded in a gelatinous matrix and make up the bulk of the fruiting bodies. Just below the surface of the fruiting body, certain of the branches become enlarged towards their apices and are crowded with protoplasm which has a strong affinity for the cotton blue stain. These branches continue to elongate and enlarge terminally and finally at the apices they bulge out to form the young, subglobose basidia (FIG. 6) in which, judging by the size of the nucleus in each one, nuclear fusion takes place not long after the subglobose bodies have become well

rounded. According to the results of Dangeard's² studies on *Tremella mesenterica* the nucleus divides shortly after fusion and the basidium becomes longitudinally divided into four cells, each of which then produces a relatively stout and rather elongate sterigma upon which a spore is produced. A similar procedure is followed by this species, since although the material is not satisfactory for cytological study, the nuclei, conspicuous before division, later become very much smaller and then are readily obscured by the oil drops that are formed in each cell. The basidiospores (FIGS. 2, 4) are subspherical or ovoid and with an oblique apiculus. They germinate (FIG. 4) by sending forth a single short germ-tube at the end of which minute bacteria-like ovoid sporidia are produced.

A careful examination of the hyphae from which the basidia arise makes it evident that all of the branches do not develop into reproductive structures. Instead, many of them continue to elongate and to divide subdichotomously until they project beyond the level of the basidia. These branches, vacuolate and not readily stained, appear to be morphologically identical with the conidia bearing branches described by Dangeard (*l.c.*), but in no instance has the writer been able to find conidia or any evidence of their formation. Since such is the case, it would appear that they are the sterile ends of the hyphae that make up the bulk of the fruiting body, and like them, they are capable of secreting the same mucilaginous substance that forms the matrix of the rest of the pustule. Possibly these sterile ends may be called paraphyses, but if so, in this instance, it would appear that their function is one of secretion and hence they serve to protect the basidia from desiccation. At the same time one should not overlook the possibility that they are conidiophores which, during the evolution of the species, have lost their capacity to produce conidia.

Determination of the taxonomic position of this somewhat unusual species, because of its shape and repent nature, at first offered some difficulties. By using one key to the genera of the Tremellaceae, because of the unilateral hymenium, this species would appear to belong in the genus *Exidia*, whereas in another

² Dangeard, P. A. Le Botaniste 4: 119-181, figs. 6-7. 1895.

key, the species, on account of the shape of the spores, would fall into *Tremella*. Furthermore, if the color of the fructification is emphasized as is true in still other keys, this species would be without any apparent connection. A review of the literature in an endeavor to clarify the somewhat confused ideas as to what characters should be used to separate the genera, indicates that such gross morphological characters as color and shape of the fruiting bodies do not serve as well as do the microscopical characters such as the structure of the tissue, the shape of the spores and of the sporidia. According to these criteria, and apparently in agreement with the ideas of most mycologists, the genus *Tremella* is characterized by possessing a rather uniform and gelatinous context, subspherical to ovoid basidiospores, and ovoid, not horse-shoe-shaped, sporidia. The present species agrees in all details with this conception and hence is placed in *Tremella*, but in this genus few of the species are white, all are larger, and not one of them is recorded as producing fruiting bodies of the same striking yet characteristic form. The fungus is therefore deemed worthy of recognition as a new species for which the name *Tremella gangliformis* is proposed.

***Tremella gangliformis* sp. nov.**

Fructificationes resupinatae, gangliformes raro pulvinatae, gelatinosae, albiae deinde cremeae, 0.2–2 mm. longae, 64–144 μ latae; contexto hyalino; basidiis ovoideis, longitudinaliter cruciate septatis, 6.5–7.5 \times 8.5–12 μ ; sterigmatibus quater, 1.5–2 \times 36–40 μ ; sporis hyalinis, levibus, subglobois vel ovoideis obliquiterque apiculatis, 4–5 \times 5.5–6 μ .

Fructifications resupinate, gangliform, rarely pulvinate, gelatinous, white drying to cream color, 0.2–2 mm. long, 64–144 μ wide; context hyaline, the hyphae slender, less than 1 μ in diameter, much branched, without clamp connections, imbedded in a gelatinous matrix; basidia when young subglobose, later ovoid and longitudinally cruciate-septate, 6.5–7.5 \times 8.5–12 μ , bearing four sterigmata, 1.5–2 \times 36–40 μ ; basidiospores hyaline, even, subglobose to ovoid and obliquely apiculate, 4–5 \times 5.5–6 μ .

On saturated decaying elm wood, near Fenton, Missouri, March 23, 1931, *Linder*. TYPE, in Farlow Herbarium, Harvard University.

OBSERVATIONS ON EPIDERMOPHYTON RUBRUM OR TRICHOPHYTON PURPUREUM¹

E. MUSKATBLIT

(WITH 3 TEXT FIGURES)

Epidermophyton rubrum belongs to the pathogenic fungi which are rather common in the United States. In Weidman's (1) statistics of American species obtained from 272 cases of epidermophytosis and onychomycosis, *Epidermophyton rubrum* was the third organism in order of frequency (17 cases). *Epidermophyton* (or *Trichophyton*) *interdigitale* was the most frequent (140 cases) followed by *Epidermophyton cruris* (54 cases). In our clinic during a period of twenty-three months cultures of various fungi imperfecti were grown from 109 cases of fungous infection of the glabrous skin and nails. As in Weidman's series, *Epidermophyton rubrum* was third in frequency (17 cases), *Epidermophyton interdigitale* being first (55 cases) and *Microsporon* second in order of frequency (21 cases).

Considerable variations in gross as well as microscopic morphology of cultures make the identification of *Epidermophyton rubrum* at times rather difficult. The following brief review of literature makes this point obvious. Castellani (2) first described this fungus in 1910 and called it *Epidermophyton rubrum*. Cultures on glucose and maltose agar isolated from cases of *Tinea cruris* were red and showed either a central knob or a crateriform appearance.

Almost simultaneously Bang (3) cultivated from lesions of the glabrous skin a species which he called *Trichophyton purpureum*. On glucose medium its colonies were white and downy, with elevated centre, around which there developed later a powdery zone with radial folds. The deep layer of the culture gradually assumed a red color visible only on transillumination or on the

¹ From the Department of Dermatology and Syphilology, University & Bellevue Hospital Medical College, Service of Dr. Howard Fox.

back of the colony. On conservation medium the culture grew slowly, and was covered with a short grayish white duvet, red pigmentation being absent even in old cultures.

In spite of considerable differences described by Castellani and Bang, Sabouraud (4) in 1911 expressed the opinion that *Epidermophyton rubrum* of Castellani and *Trichophyton purpureum* of Bang were identical organisms.

Priestley (5) in 1917 isolated from erythemato-squamous lesions of the glabrous skin a fungus which he called *Trichophyton rubidum*. On glucose medium its cultures were creamy-white with a short duvet but the medium under and around the colony assumed later a deep red color.

Hodges (6) in 1921 described cultures grown from cases of onychomycosis which he provisionally called *Trichophyton* "A" and *Trichophyton* "B." Both produced white and downy colonies. *Trichophyton* "A" developed later a pink color on the surface and purplish red on the back. *Trichophyton* "B" in primary plants became yellowish at places but in subcultures closely resembled *Trichophyton* "A" showing pinkish down on the surface and "purple color from the back." In the supplementary note to his paper Hodges admitted that *Trichophyton* "A" and probably *Trichophyton* "B" were identical with *Epidermophyton rubrum* Castellani and *Trichophyton purpureum* Bang.

Ota (7) in 1922 thought that a series of his cultures belonged to the same species although they varied greatly in their morphology. Some were white, others grayish, yellowish, brownish, lilac and red, mostly however without any red pigmentation. Their surface was downy or powdery, sometimes with radial furrows, central knob or irregular depressions and elevations.

Takahashi (8) thought that there were two varieties of *Trichophyton purpureum* Bang, one of them producing red pigment.

Bruhns and Alexander (9) admitted that white cultures described by Ota and some other Japanese authors as strains of *Epidermophyton rubrum* were possibly pleomorphically degenerated strains of primary red colonies.

Karrenberg (10) pointed out that the cultures of *Epidermophyton rubrum* varied greatly in their shape, color, depth of the growth, aspect of the surface, etc. He found it necessary to form

a group of fungi under the name *E. rubrum* including the previously mentioned species of Castellani, Bang and Priestley and also *E. Perneti* Castellani, *E. salmoneum* de Mello and *E. lanoroseum* McCarthy.

Authors disagree also on the question of pleomorphic degeneration. While Bang stated definitely that his cultures did not undergo pleomorphism, Priestley wrote that pleomorphic degeneration not only appeared early but was marked.

Some discrepancies can be found in the description of microscopic morphology of cultures. Castellani found in drop cultures only chlamydospores and a few hyphae with lateral spores. Bang and Ota saw numerous simple hyphae with lateral spores and also branched hyphae with grape-like clusters of spores and multilocular fusiform spores. Priestley described the same picture as Bang but in his cultures fusiform spores were only occasionally present and were not well developed. Hodges in his *Trichophyton* "A" found the same forms of sporulation as Bang and in *Trichophyton* "B" found only a few simple unbranched hyphae with lateral spores and fuseaux.

This brief review of literature shows clearly that the data about *Epidermophyton rubrum* are rather confusing. One gets an impression that two main types of cultures are included in this species. One is red with little or no duvet and with a central knob or crateriform or irregular surface—type *Epidermophyton rubrum*. The other is at first white and downy but later develops red pigmentation in its deep layers—type *Trichophyton purpureum* Bang. Different colonies of this fungus were usually cultivated from different patients. Hodges alone described a remarkable case where two different cultures grew from the same patient. On maltose medium one was downy with central pink area and white periphery, the other was almost smooth with scant purplish duvet. Both cultures, however, were purplish red from the back. On peptone agar the first culture showed downy, pinkish, elevated centre surrounded by a flat smooth area. The second was orange colored with irregularly convoluted centre surrounded by a wide zone made up of elevated sectors divided by radial furrows. Microscopically both types differed in the number of fuseaux, which were more numerous in the downy type. My

observations have a direct relation to this case of Hodges and I believe it would be of interest to report two cases from our clinic, in each of which two entirely different cultures were isolated simultaneously in primary plants. One type was red and cerebriform approaching *Epidermophyton rubrum* Castellani, the other was white and downy with red pigmentation of the basis, fully corresponding to *Trichophyton purpureum* Bang.

DESCRIPTION OF CASES

Case 1. J. M., male 27, negro (FIG. 1) showed on the abdomen and lower extremities numerous erythematous-squamous patches of various size and shape with well defined border. The largest



FIG. 1. *Epidermophyton rubrum*. Clinical aspects. Case 1. J. M. (See text.)

lesions occupied the upper and inner aspect of both thigh, the entire picture giving the impression of a generalized tinea cruris. Microscopic examination of scrapings in potassium hydroxide preparation revealed typical mycelia which were long, wavy,

septate and branched. Scales were planted in several tubes with Sabouraud's glucose-peptone-agar medium and gave cultures of two types. Some were red, smooth and cerebriform, others were white and downy. They differed so strikingly from the beginning of their growth that we thought of a mixed infection with two different species.

Case 2. R. L., male, 27, white, presented an eruption of the same type as in case 1, but much more generalized on the trunk, upper and lower extremities, including the palms and soles. All finger nails and all but two toe nails showed typical onychomycosis. Toe webs of both feet were macerated or hyperkeratotic. Microscopic examination of scales taken separately from the trunk, palms, soles, fingernails, toenails and toe webs showed mycelial filaments and chains of spores in all preparations. Cultures were positive from only two locations. White downy colonies grew from the toe web scrapings. Two different cultures, one red and cerebriform, the other white and downy, grew from scrapings taken from the trunk. Further study has shown that white downy cultures from both locations were identical. We have therefore in this case two types of colonies which were similar to those isolated from the first case and require but one description.

A cerebriform culture on glucose-peptone-agar (FIG. 2) started as a knob with smooth but irregular surface and of waxy yellowish color. Pigmentation developed gradually at first in the centre, later also on the periphery. The color was at first lilac and later became deep red. A fully developed culture one month old was 5 cm. in diameter. The centre was considerably elevated. The surface was powdery and made up of numerous cerebriform folds separated by deep furrows. The latter assumed on the periphery a radial disposition with slightly elevated sectors between them. Near the border the culture was flat and even. The color was deep red, lighter on the periphery. The border was sharp, of irregular outline and almost colorless. The surrounding medium at the end of the third month showed a red color particularly noticeable on transillumination. Pleomorphic degeneration developed as a rule and covered the culture with a white dense duvet. The same culture on peptone agar (FIG. 2)

had a similar morphology and was yellowish but at times the centre had a slightly lilac color. Drop cultures showed mycelia, frequently tortuous, thick and irregular with spindle shaped and knoblike terminal swellings, numerous chlamydo-spores and large multilocular fusiform spores with blunt ends and smooth thin walls. These spindles were the most prominent type of sporulation. Hyphae with lateral spores were present in small numbers in a few cultures. The powder taken from the surface of the culture consisted almost entirely of spindles and chlamydo-spores. Many mycelial hyphae and chlamydo-spores contained red pigment in the form of granules and large globules. A downy culture showed quite different gross as well as microscopic morphology. It started on glucose-peptone-agar (FIG. 3) as a white fluffy point and on the fifth week was 5 cm. in diameter. The white downy and raised centre was surrounded by a flat powdery zone with radial furrows and of a pink color more distinct on transillumination. The surrounding medium also showed a red color later.

Pleomorphic degeneration covered the culture with a dense white non-characteristic down.

The same culture on peptone agar (FIG. 3) was again white and downy with a central knob, radial furrows and slightly elevated sectors between them. The powdery pink zone was absent. Drop cultures of the downy colony differed from those of the cerebriform one. Mycelia were straight and much more regular, and some hyphae also contained granules of red pigment. Chlamydo-spores were much less numerous and multilocular fusiforms were few in number and poorly developed. On the contrary both simple and branched conidiophores with lateral spores and grapelike masses of spores were very abundant. Some hyphae showed the phenomenon of absorption leaving rows of conidia. The powder taken from the surface of the culture consisted almost entirely of small pear-shaped conidia.

SUMMARY AND CONCLUSION

Two different types of cultures were isolated from each of two patients with lesions of the glabrous skin. These two types showed from the beginning of their growth as well as in further

development, different gross and microscopic morphology and behaved like two independent species. The cerebriform type coincided in its main features with *Epidermophyton rubrum* Castellani, the downy type corresponding to the descriptions of *Trichophyton purpureum* Bang. The downy culture cannot be considered as pleomorphic degeneration of the primary cerebri-

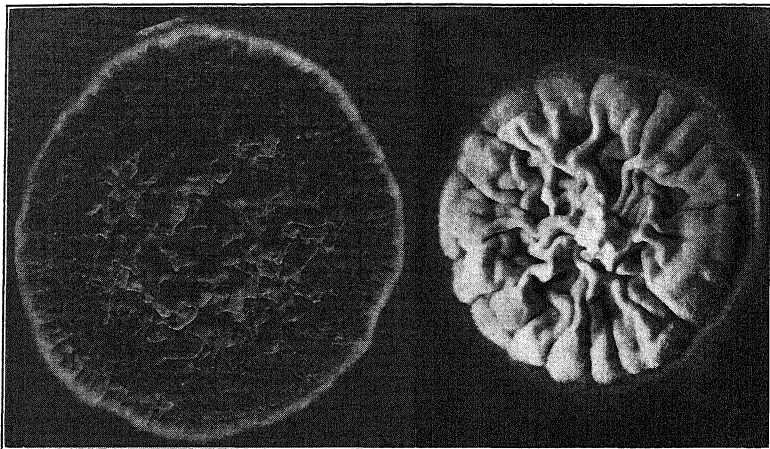


FIG. 2. *Epidermophyton rubrum*. Cerebriform type. Left, glucose-peptone-agar medium. Right, peptone-agar medium.

form one since (1) it developed white and downy as a primary colony directly from planted scales, (2) it showed abundant and characteristic sporulation whereas pleomorphic cultures are sterile or contain few and poorly developed spores, (3) it underwent a pleomorphic degeneration.

Our observations together with the data of the literature allow two explanations.

1. One and the same fungus exists in at least two stable varieties, one red cerebriform with predominance of chlamydospores and multilocular spindle spores—type *Epidermophyton rubrum* Castellani. The other variety white and downy with red pigmentation of the basis and lateral conidia as the main form of sporulation—type *Trichophyton purpureum* Bang.

Both varieties can be isolated in rare instances from the same patient in primary plants.

2. Another explanation might possibly be suggested, that the red cerebriform fungus—*Epidermophyton rubrum* Castellani and white downy one—*Trichophyton purpureum* Bang—are independ-

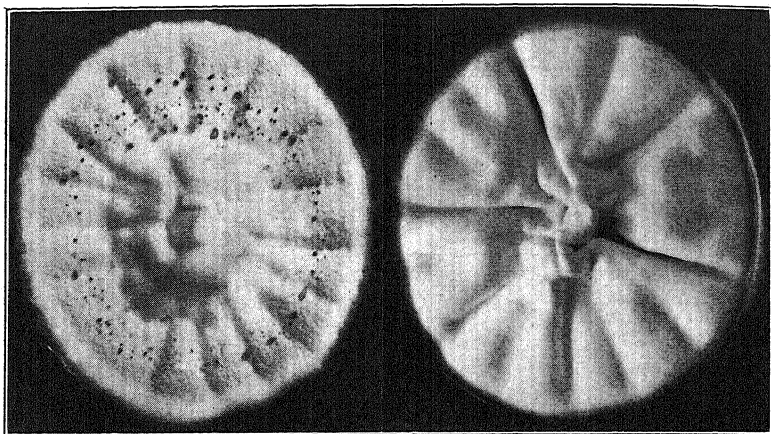


FIG. 3. *Epidermophyton rubrum*. Downy type. Left, glucose-peptone-agar medium. Right, peptone-agar medium.

ent species and may occur in the same patient as a mixed infection with two pathogenic fungi at once.

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VARIATION IN SINGLE SPORE CULTURES OF *ASPERGILLUS FISCHERI*¹

H. C. GREENE

(WITH 5 TEXT FIGURES)

In connection with a larger study of the biochemistry of the common fungi it appeared desirable to compare the action of single spore cultures with that of the parent stock cultures. When studying single spore cultures of *Aspergillus Fischeri* Wehmer certain striking macroscopic variations appeared which were investigated and are described in this paper.

Variation within supposedly homogeneous species of microorganisms has of late years been the object of much study, and many conclusions, both coinciding and conflicting, have been drawn therefrom. Within the past decade the special subject of variation in fungi has come to occupy an increasingly important position, and a great deal of information has been accumulated.

Brierley (8) has, with considerable success, attempted to classify logically types of variation reported and to correlate them in a connected whole. He divides variations into three principal types:

- (1) *Modifications*, non-heritable differences caused by the unequal influence of different conditions, and varying immediately with the conditions.
- (2) *Continuous variation*, heritable differences characterized by the gradualness of the change through successive generations.
- (3) *Discontinuous variation*, heritable differences characterized by the suddenness of their appearance.

Leonian's recent important paper (19) discusses at length the phenomena of variation, and the point is stressed that variation in many fungi is to be regarded as an entirely normal develop-

¹ This work was supported in part by a grant from the Wisconsin Alumni Research Foundation.

ment which hitherto has not been taken into account in our scheme of classification.

Many papers, *e.g.*, Arcichovskij (1), Schiemann (21), Waterman (23), Haenicke (16), Christensen (12), (13), Barnes (2), (3), Johnson (17), and Dickson (15) have dealt with variation induced or caused by more or less radical alteration of environmental conditions. Such cultural changes are in many cases undoubt-

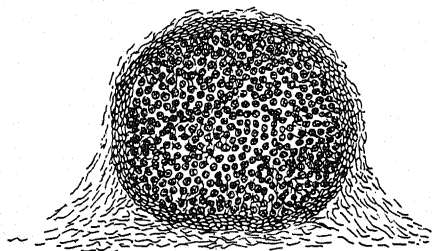


FIG. 1. Section through ordinary perithecium.

edly mere modifications in the sense of Brierley, while others seem to be remarkably permanent. Schiemann's *Aspergillus fuscus*, for example, still retains the distinctive characters Schiemann reported for it in 1912. Chodat (11) in discussing his own work with *Aspergillus ochraceus* suggests that the variation is not unrelated to the conditions of the medium in which it appears, but emphasizes that he does not impute to the medium a causal effect in producing variation. He believes that the medium should be considered as a detector which rendered visible a pre-existing alteration—a rather fine distinction, to be sure.

As stated, radical changes in cultural conditions are known to produce variations in the characters of various fungi. On the other hand, changes in characters of fungi may take place without any definite modifications of cultural conditions. Many reports, Crabill (14), Blakeslee (4), Brierley (7), Blochwitz (5), Stevens (22), Leonian (18), (19), Brown (9), Chodat (11), Mohendra (20), and Brett (6) and others, are concerned with variant forms arising principally as sectors or patches of differentiated mycelium in Petri plate colonies. Sector formation is of rather frequent occurrence and any worker is almost certain to encounter it more or less often, depending in some measure on the fungi

under study. The permanence of variants obtained from such sectors is difficult to judge, since the work has been carried out under such widely different conditions. The general impression one gains is that most of the variant forms are relatively unstable, and tend sooner or later to revert to production of characters like those of the cultures from which they were derived.

If we disregard the question of the permanence of variation, the facts still remain that striking and unmistakable cultural changes have been observed by many mycologists in the course of routine stock maintenance, and that such phenomena must be studied if mycological taxonomy is to be placed on something approaching a stable basis.

Brierley (8) emphasizes the point that there has been too much undirected work in the past, and that too little has been done in the way of constructive attempts to analyze and to correlate data. He states that he believes that "the investigations of the past few years show clearly the possibility of applying the fundamental concepts, criteria, and terminology of genetics to the last remaining groups, the fungi and bacteria." Dodge has successfully done so in his work on the heterothallic *Neurospora*. There remain, however, many fungi, homothallic and difficultly susceptible to ordinary cytological methods, which present most interesting variations, and which should be studied.

The following account of variations shown by a certain culture of *Aspergillus Fischeri*, for example, while not based upon any exact genetic criteria, nevertheless offers, it is believed, some points which may be of value to workers interested in morphological stability of cultures. With the existent uncertain state of mycological technique in general, the practical aspects of culture maintenance seem to be even more worthy of immediate attention than does the development of a body of genetically exact theory, and indeed it would seem that the latter can only come with vast improvements in empirical technique.

HISTORY AND GROSS MACROSCOPIC APPEARANCE OF THE STOCK CULTURE, *A. Fischeri* 5041

Aspergillus Fischeri Wehmer (FIG. 4, A) is one of the comparatively few Aspergilli producing both conidia and ascospores.

Thom states that the conidial form of *A. Fischeri* is not distinguishable in morphology from *A. fumigatus*. The particular culture of *A. Fischeri* used in this study was received from Charles Thom of the Bureau of Chemistry and Soils, U. S. D. A., as his culture, *A. Fischeri* 5041. The culture was carried by Thom on Czapek's agar, and has been carried in this laboratory since

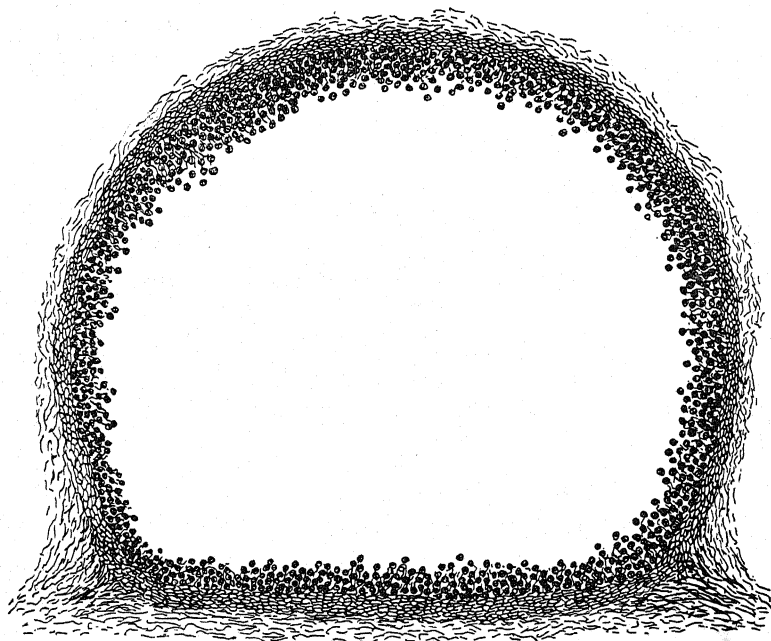


FIG. 2. Section through variant perithecium.

September, 1930, on malt extract agar of the same composition as that used throughout this study. It must be remembered that the following description of gross cultural characters applies necessarily only to the particular culture used, under the special conditions of this study.

When *A. Fischeri* 5041 is transferred to fresh slants or plates of malt extract agar, sterile, white, not pronouncedly aerial mycelium first appears. The white is soon replaced by a light gray-green due to the sparse, but fairly uniform, production of conidia over the whole growth area. This represents the appearance of the culture at about the end of the third day. Shortly

after this the culture begins to show small, whitish flecks, evenly and uniformly distributed throughout. The flecks are immature perithecia. At the end of approximately ten days the white perithecia are mature, that is to say, their content of asci and ascospores is fully developed. The mature perithecia assume such size and become so closely crowded that the rather short conidiophores are no longer apparent, and the whole appears as a practically pure stand of white, globular perithecia (except at the point of inoculation where conidial development is somewhat greater), about $\frac{1}{8}$ mm. in diameter, or somewhat less. In the case of a slant, at its uppermost tip, where the agar has dried down, perithecia are not produced, while the gray-green conidia appear in profusion. The characters of the stock have been maintained with constancy, and following mass transfer no significant variation has occurred during the two years that the culture has been carried.

EXPERIMENTAL

Handling of the stock culture and of single spore cultures. All cultures were kept under uniform conditions. They were carried on malt-extract agar of pH 5.0, were kept continuously at 26° C. in a darkened incubator, and were transferred at one month intervals. Many of the cultures have not been kept in stock, but were discarded as they dried up. The malt-extract agar is made up as follows: plain malt-extract (Trommer's Analyzed) 25 g., agar 20 g., distilled water 1000 cc.

Method of isolation of single spore cultures from A. Fischeri. Because of the small size of the hyaline spores, the simple methods adapted to the isolation of large, dark spores, cannot be used here. It is, therefore, essential to employ a method such as gives satisfactory and certain results in the isolation of single bacterial cells. A modified Chambers micro-manipulator was found to be well adapted to the work (15a).

In preliminary trials about 50 ascospores were isolated on clear malt-extract agar drops, but under the conditions used, the spores without exception failed to germinate. The expedient of first germinating the spores in malt-extract broth, and isolating germinated spores was resorted to with success. All single spore

cultures studied, whether from ascospores or conidia, were derived from pre-germinated spores. The single germinated spores were deposited on drops of malt-extract agar, on sterile cover slips. The cover slips, with agar drop and spore, were sealed with sterile vaseline to deep hanging drop slides, and were incubated for 48 hours in a darkened incubator. The development of the spores can be followed in detail in the early stages, and the danger of carrying unwittingly contaminated cultures is reduced to a minimum. After the incubation period, cultures were transferred with a small, sterile spatula to ordinary culture tube slants of malt-extract agar and maintained in the usual way.

Isolation of germinated ascospores of A. Fischeri 5041. Ascospores of *A. Fischeri* are characterized by being enclosed between two rather closely fitting valves. The valves, due to the projection of their edges, form an equatorial ridge about the spore, and ascospores are thus, by their distinctive appearance, easily differentiated from the conidia which have no such valves. When the ascospores germinate the valves are forced apart and may, or may not, adhere to the germinated spore. Since a germinated ascospore which has shed its valves does not differ in any well-defined and tangible way from a germinated conidium, it is necessary in isolating germinated ascospores to pick only those which show the two characteristic valves still clinging to the spore.

In the course of this study it became desirable to isolate both germinated ascospores and germinated conidia, and a procedure was adopted with this in view.

Methods for the differentiation of germinated conidia from germinated ascospores in the isolation of single spore cultures. To secure comparable results, it was deemed necessary to isolate both conidia and ascospores from the same slant culture. Since spores were isolated only after germination, and, as mentioned, a germinated conidium cannot with certainty be differentiated from a germinated ascospore which has lost its valves, two practical courses for separation lay open:

1. The isolations of conidia could be made from a 4 or 5 day old, initially ascospore-free culture, whose own ascospores had not yet matured. Such a culture would of necessity be a subculture obtained from a stock slant culture. The mass inoculum, con-

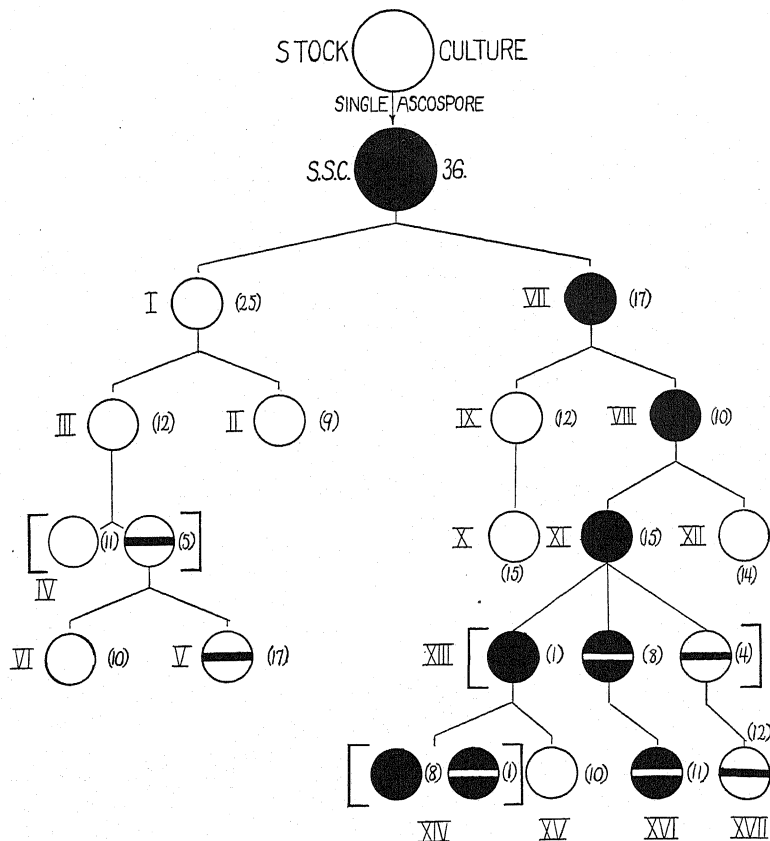
CULTURAL RELATIONSHIPS OF S.S.C. 36
AND ITS SINGLE SPORE DERIVATIVES

FIG. 3. Roman numerals refer to cultural group numbers (see pp. 128-131). The number of cultures contained in each of the cultural groups indicated by the Roman numerals may be ascertained by reference to the Arabic numerals in parentheses. Unshaded circles indicate cultures resembling the original stock culture, *A. Fischeri* 5041. Completely shaded circles indicate variant cultures resembling S.S.C. 36. Circles with a black central bar indicate cultures showing a slight tendency toward the production of variant characters resembling those of S.S.C. 36. Shaded circles with a white central bar indicate variant cultures showing a tendency toward reversion to the production of characters resembling those of the stock culture.

sisting of a mixture of mycelium, conidia, and ascospores, would be placed as a drop of water suspension on the surface of an upright agar slant. Then, as the mycelium grew toward the upper limit of the slant, and before ascospores matured, a transfer could be made, ascospore-free to another slant, and the conidia for isolation obtained from the latter slant. This procedure was tried out and some single conidium cultures were obtained from the central portions of various slants (primary conidial isolations from S. S. C. 36, in part—see p. 130). It was found, however, that to secure an adequate suspension of conidia it was necessary to so disturb the growing culture as to introduce a serious question as to the comparability of the single ascospore cultures to be obtained later in the growth period. Further than this, assuming that the disturbance of the culture did not of itself influence results, there was the ever-present cultural age factor. That is to say, conidia would be isolated when the culture was 4 days old and ascospores not until 12 days old. This procedure was therefore abandoned.

2. In the ordinary slant of *A. Fischeri* and such of its single spore derivatives as studied (aside from cultures like single spore culture 20), the following obtains when the culture has reached an age of 2 to 3 weeks. There are relatively few conidia in the deeper portions of the slant, while perithecia are produced there in greater or less profusion. Conidia are developed abundantly only at the dried-down uppermost tip of the slant. Perithecia have never been observed in this upper portion. Therefore, the following procedure was adopted and adhered to throughout the study. Cultures were allowed to attain to complete maturity undisturbed, and then conidia from the uppermost portion were transferred to suspensions, the isolation of conidia always shortly preceding that of ascospores. The ascospores are rather firmly held in the semi-mucilaginous, non-ostiolate perithecia, and do not tend to fly about under any conditions. The possibility of the presence of stray ascospores was repeatedly checked by extended microscopic observation, both when isolations were being made and otherwise, and, in cultures handled as described, no ascospores were ever observed among the conidia. Conidia, under the conditions here used, germinate freely within 8

hours. On the other hand, no germinated ascospore with valves adhering, and very many have been observed, has ever been seen within less than 15-16 hours after incubation. Conidia were always picked within 8-10 hours after being placed in the malt-extract broth. Both conidia and ascospores were isolated from slants 2 to 3 weeks old, or in some instances somewhat older.

In all, 448 single spore cultures have been derived, either directly or indirectly, from the stock culture.

Morphological variations in single spore cultures 1-79. The great majority of these single ascospore cultures reproduced, on initial culturing (FIG. 4, b), the characters of the stock culture from which they were derived, namely *A. Fischeri*. Thus, the fungus is definitely homothallic. Certain striking gross variations were manifested in a few of the cultures. These variations may be described as follows: (S.S.C. will hereafter be used to indicate "single spore culture").

S.S.C. 20 (FIG. 4, d). A profuse stand of conidiophores bearing the characteristic gray-green conidia was produced. Perithecia were formed very sparingly and tardily, appearing only about a week after isolation. There was little or no aerial mycelium when the culture was first isolated.

S.S.C. 21. This was similar to S.S.C. 20, but had abundant, whitish aerial mycelium which later turned a gray-green color as a result of production of conidia.

S.S.C. 36 (FIG. 4, c). S.S.C. 36 differed strikingly from the stock culture in forming comparatively few, scattered perithecia, some of them of very great diameter. The average size of a large number of perithecia was about 350 μ with very few under this, but in addition there were also a considerable number of very prominent perithecia, so large that it was not felt that they could be rightfully included in an average. In general, size increased proportionally as the distance apart of the perithecia increased. Hence the large perithecia, standing by themselves, were very conspicuous. The largest perithecium measured was more than 1800 μ in diameter, while five of the ordinary large perithecia, taken at random, measured: 1040 μ , 925 μ , 885 μ , 850 μ , 1000 μ . Comparatively few asci were borne in the large perithecia, contrary to the state of affairs existing in the small perithecia, and

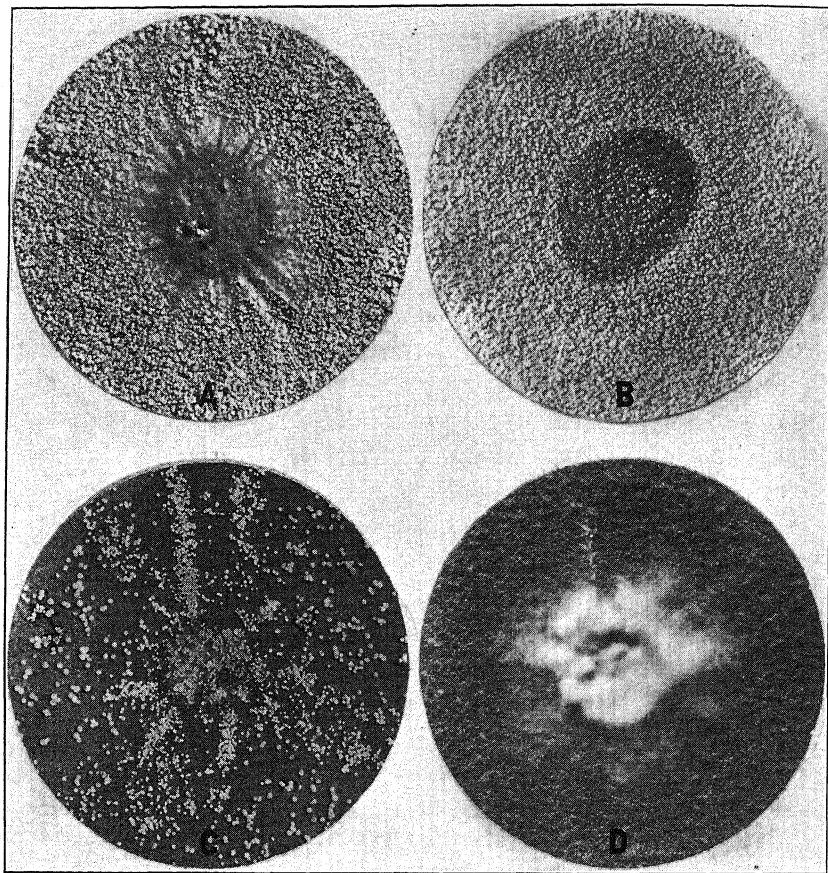


FIG. 4. A, The stock culture, *A. Fischeri* 5041, showing the small, white closely distributed perithecia. (The darker central area is a conidial overgrowth arising at the point of inoculation of the colony); B, S.S.C. 49, a typical single ascospore culture, resembling the stock; C, S.S.C. 36, a variant single ascospore culture, showing the comparatively large, scattered perithecia. (Photograph taken 1 month after original isolation); D, S.S.C. 20, a variant single ascospore culture, showing conidial development, with practical exclusion of perithecial formation. (Photograph taken after 3 months original isolation.)

consequently as the culture aged, the perithecia tended to collapse (see FIGS. 1 AND 2). Ascus and ascospore size remained constant, regardless of perithecial variation.

S.S.C. 38, 51, 52, 59, 74, 78. All these cultures were similar to S.S.C. 20.

S.S.C. 76 (FIG. 5, a, b). This resembled S.S.C. 36, but had even larger perithecia. The average diameter of 50 of them, excluding certain immense individuals as in the case of S.S.C. 36, was about 500 μ . The largest perithecia measured from 2000–3000 μ in diameter.

Morphological variations appearing in single spore cultures 80–108. These cultures were derived from single conidia, as opposed to S.S.C. 1–79 of ascospore origin. The variant cultures are as follows: S.S.C. 83, 103, 104, 106.

These were all similar to the single ascospore variant, S.S.C. 20.

S.S.C. 108. This culture introduced a new type of variation consisting in a dense stand of conidiophores and conidia, with perithecia of ordinary size quite regularly and uniformly placed in the conidial mass. It represents a type intermediate between S.S.C. 20 and the stock culture.

When grown on Petri plates, the variant forms, ascospore or conidial in origin, developed uniformly and reproduced with little sign of further variation, such as sectoring.

Study of variant single spore cultures. S.S.C. 36 showed characters differing in such a high degree from those of the stock culture that a rather extended study of this variant culture was undertaken, and many single spore cultures were derived from it. A short summary of the salient characters of the stock and variant is here presented, and is followed by a description of the work carried out with S.S.C. 36 and its single spore derivatives.

1. *A. Fischeri* 5041. The mature stock culture appears as an almost pure white growth fringed, in the upper dried down portion of the agar slant, with a gray-green band of conidia. Close inspection reveals that the white is due to massed, uniformly and closely distributed, globular perithecia, averaging about 250 μ in diameter. There is no wide variation in perithecial size, and the perithecia are rather compactly filled with asci and ascospores. Conidiophores with their conidia are also to be found

among the perithecia, but the conidiophores are so short and the conidia relatively so few, that they are hardly apparent to the naked eye. On a plate the appearance is similar, with conidia often developing rather abundantly at the point of inoculation and at the edges as the agar dries down.

2. *S.S.C. 36*. This culture varies from the stock in producing comparatively few perithecia, practically all of them of a greater diameter than those of the stock culture, and many of them of a very much greater size. The larger perithecia, especially, are decidedly scattered, and as a consequence stand out very prominently. Conidia appear in the same position and under the same conditions as in the stock culture.

Single ascospore cultures from S.S.C. 36 (see FIG. 3, p. 123) (and single spore cultures derived from this ascospore group):

I. 25 single ascospore cultures from *S.S.C. 36* produced, *not* the variant form, but developed without exception into cultures indistinguishable from the stock culture *A. Fischeri* 5041 (from which *S.S.C. 36* arose as a single ascospore culture).

II. 9 single ascospore cultures, from one of the 25 primary single ascospore cultures of group I, likewise produced the characters of the stock culture.

III. 12 single conidium cultures, from the same culture as the 9 single ascospore cultures of group II, produced the characters of the stock culture.

IV. 16 single conidium cultures, derived in turn from one of the 12 single conidium cultures of group III, showed in 5 cases a slight scattering of the perithecia. Furthermore, the perithecia had a somewhat larger average diameter than those of the stock culture. In other words, a tendency appeared in the direction of manifestation of characters resembling those of *S.S.C. 36*. The other 11 single conidium cultures of this group had the appearance of the original stock culture.

V. 17 single conidium cultures, from one of the 5 single conidium cultures of group IV, mentioned as showing a tendency to give rise to variant characters resembling those of *S.S.C. 36*, showed characters in every case practically identical with those of the parent culture. That is to say, no cultures with the characters of the original stock culture, *A. Fischeri* 5041, were ob-

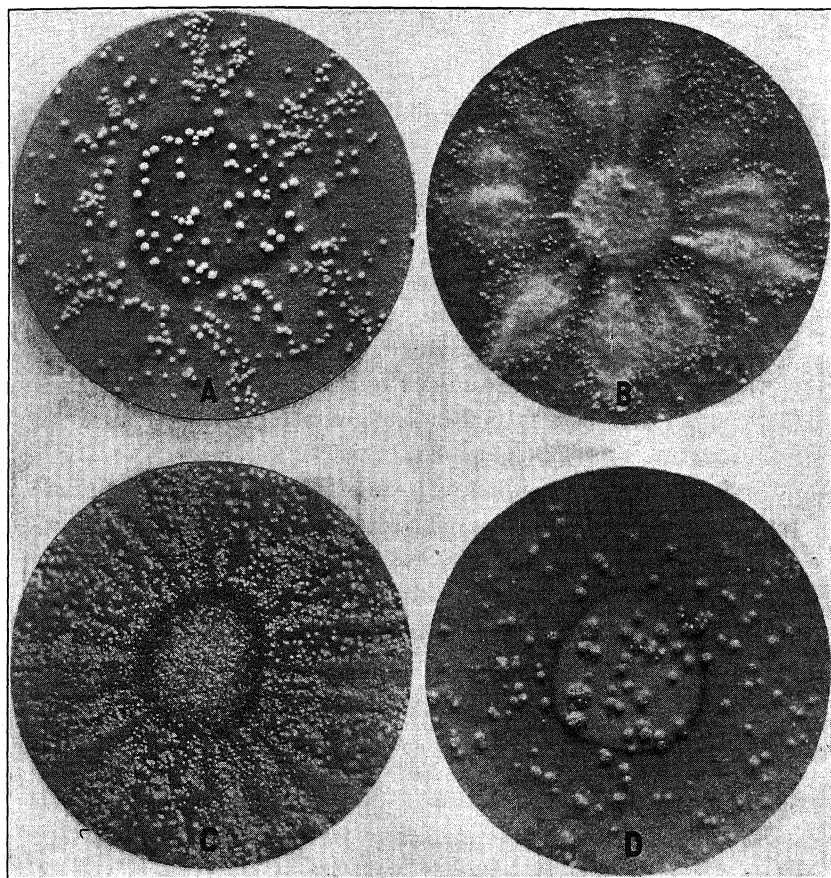


FIG. 5. A, S.S.C. 76, a variant single ascospore culture, even more striking than S.S.C. 36. (Photograph taken shortly after original isolation); B, S.S.C. 76 (Photograph taken after $3\frac{1}{2}$ months of culturing); C, S.S.C. 36 (Photograph taken after $6\frac{1}{2}$ months of culturing, showing the loss of the original variant characters); D, Five-times-removed single conidium derivative from S.S.C. 36, showing the persistence of the variant characters, when carried along through single spore culture series.

tained. However, there was no greater tendency toward characters resembling those of the variant S.S.C. 36 than had appeared in the parent culture.

VI. 10 single ascospore cultures, from the same single conidium culture as the 17 single conidium cultures of group V, produced without exception the characters of the original stock culture, thus differing significantly from the parallel cultures of group V.

This particular cultural line was not further investigated.

Single conidium cultures from S.S.C. 36 (see FIG. 3, p. 123) (and single spore cultures derived from this conidium group):

VII. 17 single conidium cultures from S.S.C. 36 reproduced, without exception, the characters of the variant parent culture. (7 of these cultures, not further used, were obtained by tentative isolation procedure (1) see p. 124.)

VIII. 10 single conidium cultures, from one of the 17 single conidium cultures of group VII, likewise reproduced without exception characters resembling those of the variant S.S.C. 36.

IX. 12 single ascospore cultures, from the same variant conidium culture as the 10 single conidium cultures of group VIII, produced, however, characters like those of the original stock culture, *A. Fischeri* 5041.

X. 15 single conidium cultures, from one of the 12 single ascospore cultures of group IX, showed likewise the characters of the stock culture.

This particular sideline, including groups IX and X, was not further investigated.

XI. 15 single conidium cultures, from one of the 10 variant single conidium cultures of group VIII, reproduced without exception the characters of the variant S.S.C. 36.

XII. 14 single ascospore cultures, from the same variant conidium culture as the 15 single conidium cultures of group XI, showed without exception characters like those of the original stock culture.

XIII. 13 single conidium cultures, from one of the 15 variant single conidium cultures of group XI, showed only one culture which reproduced essentially the characters of the variant S.S.C. 36. Of the other 12 cultures, 8 showed an intermediate tendency

toward production of characters resembling those of the original stock culture, while the other 4 showed a very pronounced tendency in that direction.

XIV. 9 single conidium cultures, from the one single conidium culture of group XIII reproducing the characters of the variant S.S.C. 36, showed likewise the variant characters, with the exception of one culture which showed an intermediate tendency toward characters resembling those of the stock culture.

XV. 10 single ascospore cultures, from the same single conidium culture as the 9 single conidium cultures of group XIV produced, without exception, characters like those of the stock culture, *A. Fischeri* 5041.

XVI. 11 single conidium cultures, from one of the 8 single conidium cultures of group XIII which showed an intermediate tendency toward producing characters like those of the stock, showed in all cases that same tendency, but in no more marked degree.

XVII. 12 single conidium cultures, from one of the 4 single conidium cultures of group XIII which showed a pronounced tendency toward characters like those of the stock culture, showed here the same tendency, but in no more marked degree, in all cases save one. This one exception appeared identical with the stock culture and it is considered possible, but improbable, that a germinated ascospore, minus its valves, was accidentally isolated.

It will have been noted from the study of S.S.C. 36 and its derivatives that all single ascospore cultures, within the large group of single spore cultures derived from the variant S.S.C. 36, produced *not* characters differing from those of the original stock culture, but characters in every case, for all practical purposes, identical. The variations, of whatever type, seem to be transmitted through the conidia, although it must not be forgotten that S.S.C. 36 itself is a single ascospore culture.

Since the variant S.S.C. 76 showed morphological peculiarities similar to those of S.S.C. 36, it was studied along the same lines, to see whether the findings made in the case of the latter culture would hold also for S.S.C. 76.

Single ascospore cultures from S.S.C. 76 (and single spore cultures derived from this ascospore group):

I. 15 single ascospore cultures reproduced the characters of the variant S.S.C. 76. Thus they did not, as did ascospore cultures from S.S.C. 36, produce characters similar to those of the stock culture.

II. 17 single conidium cultures, from one of the 15 single ascospore cultures of group I, reproduced without exception the characters of the variant S.S.C. 76.

III. 8 single ascospore cultures, from the same variant ascospore culture as the 17 single conidium cultures of group II reproduced, in the main, the characters of S.S.C. 76. Only three cultures, however, were as striking as S.S.C. 76, while measurements of perithecia of the others showed them to be about of the order of S.S.C. 36.

Single conidium cultures from S.S.C. 76 (and single spore cultures derived from this conidial group):

IV. 14 single conidium cultures reproduced, without exception, the characters of the variant S.S.C. 76.

V. 13 single conidium cultures, from one of the 14 single conidium cultures of group IV, reproduced in all cases except two the characters of S.S.C. 76, while the two exceptions were, as measurements showed, about of the order of S.S.C. 36.

VI. 11 single ascospore cultures, from the same single conidium culture as the 13 single conidium cultures of group V, reproduced in 5 cases the characters of the variant S.S.C. 76, while the other 6 were somewhat less pronounced, although still very distinctive.

The study of S.S.C. 76 and its derivatives was not carried further. The results show that, whatever its morphological similarity to S.S.C. 36, the resemblance ended there, insofar as ascospore derivatives are concerned.

S.S.C. 20, representative of the second outstanding type of variation from the stock culture, was the source of certain single spore culture groups, as outlined in the succeeding paragraphs.

Single spore cultures from S.S.C. 20:

I. 8 single conidium cultures from S.S.C. 20 reproduced the characters of this variant culture.

II. 9 single ascospore cultures from S.S.C. 20 likewise reproduced the characters of the parent.

At a somewhat later date a number of Petri plate cultures of S.S.C. 20 were made, and numerous wedge-shaped sectors appeared (these had not occurred in earlier plates) which were composed of perithecial stands, like those of the stock culture. It is not considered probable that any of these sectors arose as a result of contamination with spores of the stock culture for the appearance of all plates was homogeneous, and no foreign contamination of any sort was observed, contamination which would be expected had the handling of the plates been so faulty as to allow such wholesale seeding with spores, presumably from the stock culture.

III. 10 single conidium cultures from such a plate reproduced, without exception, the characters of S.S.C. 20.

IV. 9 single ascospores derived from perithecia of a sector showed numerous scattered tufts of white, aerial mycelium, but were otherwise similar to S.S.C. 20.

Cultural characters of single spore cultures upon repeated transfer. Insofar as investigated, the cultural characteristics of the single cell cultures, whether of ascospore or conidial origin, do not, upon the whole, appear to remain fixed. The type which on first culturing showed characters similar to those of the stock culture seems in most cases, but not in all, to change more or less rapidly after three to five transfers. Transfers were made at one month intervals, the cultures being continuously maintained at 26° C. The change is manifested by a more or less sudden loss, in large part, of perithecial production with a predominant gray-green conidial overgrowth becoming the outstanding feature of the culture. The stock culture can be made to assume somewhat of the same appearance simply by growing it at 35-37° C., a thing which seems to favor production of conidia and suppression of perithecia. There has appeared no tendency to revert back from this conidial growth when once it becomes established.

Single spore cultures of the type of S.S.C. 20 (vigorous conidial production upon original isolation) eventually go to the formation of large amounts of sterile mycelium, with conidial production apparently considerably diminished, although this is a difficult matter to judge.

S.S.C. 36 (FIG. 5, c) is not as distinctive as when first isolated

in a large measure resembling the stock culture, but it has not gone over to excessive conidial growth. Such cultures as were derived from S.S.C. 36 and its successive derivatives have, as far as they have been maintained in stock, shown considerably greater constancy in their characters, than single spore cultures derived directly from the stock culture. It should be noted that all single spore cultures except the seven mentioned on page 130 from S.S.C. 36 and its derivatives were obtained from *original* single spore isolation cultures. That is, no single spore cultures were obtained from subcultures of any other single spore cultures, but all were secured directly from the original slants of the cultures in question. Using this system it has proved possible to obtain, five months after the isolation of the original S.S.C. 36, several-times-removed derivatives, which exhibit characters fully as striking as, or more striking than, those of S.S.C. 36 at the time of first isolation (FIG. 5, d), although it has now in a large degree lost those characters.

DISCUSSION

The results obtained with S.S.C. 36 and its single spore derivatives indicate a definite difference in the developmental potentialities of conidia and ascospores, in the case of this particular culture. S.S.C. 76, however, a variant with similar morphological features showed no such differentiation. Apparently, no generalization can be set forth concerning the behavior of single spore cultures derived from variants of this type.

In view of the attempts made to maintain uniformity of environmental conditions, the phenomena described can hardly be explained solely on the basis of changes in such conditions.

An objection may be advanced that, since single conidium cultures were grown from spores taken from the upper, dried-down tips of agar slants, while ascospores came from perithecia in the moist central portion of the culture, here is a difference in environment which might be sufficient to cause significant changes.

Christensen (12) studied variation in *Helminthosporium sativum* and found that sectoring occurred only in the thinner agar layer of slanted Petri plates, which layer is, of course, comparable to the tips of slants. It is thus possible that one is merely carry-

ing the variation along by taking conidia from the upper region of the slant, and that under comparable conditions there would really be no difference in the potentialities of conidia and ascospores.

Brown (9) worked with *Fusarium* and found that the characters of a parent culture could be most readily perpetuated by taking inocula from the growing edge of a culture. He notes that the proportion of inocula which gave rise to variants increased with the age of the culture and was greater in the central region of the culture than nearer the margin. Thus, starting with a variant culture there might be a possibility that when conidia are taken from the margin of the culture, the cultural characters are perpetuated, whereas when ascospore cultures revert to the type of the stock culture, there occurs what is in effect a further variation.

Mohendra (20), using various fungi, found that when, under specified conditions, he employed inocula of different types such as old mycelium, young mycelium, and spores, he was able to demonstrate no variations, even though the fungi were perpetuated in this fashion through a number of generations.

The results of Christensen and Brown would tend to show that environmental factors may possibly have been operative in the course of the present work. It should be noted, however, that S.S.C. 36.36-36.42 which produced the variant type were derived from conidia from the central portions of young, vigorously growing, ascospore-free cultures of S.S.C. 36, while all the other single conidium cultures which gave rise to the variant type were derived from conidia taken from the tips of slants. Further than this, S.S.C. 36 and S.S.C. 76, both of them variant cultures from the stock culture, arose from ascospores taken from the moist central portion of the slant. Also, single conidium cultures derived from single ascospore cultures within the S.S.C. 36 cultural group did not give rise to cultures differing from the parent culture, except for one case where there appeared a slight tendency in that direction (group IV). Since the data of Brown and Christensen are, in a sense, opposed, it is obvious that by shifting their findings about, one can apply them after a fashion to the facts just mentioned, but certainly not with consistency. If one

seeks to explain the results of the present investigation with S.S.C. 36 on the basis of direct environmental influence, it is hard to reconcile the findings obtained with S.S.C. 76 which was manipulated in the same way, although it must be admitted that there is no direct comparison here.

Chaudhuri (10) regards the average case of variation as purely a nutritive phenomenon, and states that the vast majority of variants can be made to revert to their original forms by culturing on a suitable type of medium. Most of the cases of variation to which he refers have been manifest in sector formation. The stock culture, *Aspergillus Fischeri* 5041, has been grown on plates on numerous occasions, using the same medium on which the single spore variants arose, and insofar as sector formation is concerned, has only occasionally given rise to narrow sectors characterized by an overgrowth of sterile mycelium, and never to anything remotely resembling the type of variation exhibited in S.S.C. 36 and S.S.C. 76.

If one is inclined to accept the following definition of mutation as quoted by Brierley (8), the variations described in this paper certainly cannot be regarded as being of the order of mutations. Thus, mutation is "The result of a change in genotypic constitution occurring independently of normal segregation, crossing-over, or irregular chromosome division; strictly an alteration in the fundamental nature of the germplasm, usually in a single gene" (Jones 1925). It is as well perhaps to avoid the use of "mutation" and to adhere to such terms as "variation" and "saltation," although as Brown (9) says, there seems to be little reason for sharing in Brierley's anxiety over the lamentable consequences of the indiscriminate use of "mutation," for after all, every reader of microbiological literature is so accustomed to the use of the word in the sense of ordinary variation, that no particular confusion is likely to be occasioned when "mutation" is loosely employed.

SUMMARY

Using a modified Chambers micromanipulator, 448 single spore cultures were obtained from a stock culture of *Aspergillus Fischeri*, a perithecial form. Certain of these cultures showed striking morphological variations from the stock culture, and this paper is concerned with a study of the variant cultures.

Variant cultures were of two main types: (1) Very large, scattered perithecia were produced, as opposed to the condition in the stock culture where the perithecia are small, and closely and uniformly distributed. (2) Conidia were produced in profusion, while very few perithecia were formed and those only tardily, contrary to the case in the stock culture.

In the case of a certain culture of type (1), cultures derived from it, both from ascospores and conidia, through several single spore generations reproduced the characters of the variant parent. In another instance, however, single ascospore derivatives through a number of single spore generations produced *not* variant cultures, but cultures practically identical morphologically with the original stock culture. Cultures derived from conidia, on the other hand, reproduced the variant type. Single spore cultures from a type (2) variant reproduced the variant characters, whether the cultures were derived from single ascospores or single conidia.

DEPARTMENTS OF AGRICULTURAL BACTERIOLOGY AND
AGRICULTURAL CHEMISTRY, UNIVERSITY OF
WISCONSIN, MADISON, WISCONSIN.

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DERMEA AND PEZICULA¹

FRED J. SEAVER AND JOSEFA VELAZQUEZ

(WITH PLATES 20-23 AND 1 TEXT FIGURE)

The genus *Dermea* was founded by Fries (Syst. Orbis Veg. 343. 1825) and later changed to *Dermatea* by the same author. Fries changed the spelling of the name apparently for etymological reasons, but the original spelling is here retained in accordance with the rules in spite of the fact that the latter is in common use. Although not the first species mentioned *Peziza Cerasi* of Persoon is usually regarded as the type of the genus and probably fittingly so since it is widely distributed, well known, and a species of economic importance.

In 1865 Tulasne established the genus *Pezicula* based on *Peziza carpineae* Persoon, a species common on *Carpinus*. There seems to have been some difference of opinion as to the grounds for the separation of these two genera. Lindau (E. & P. Nat. Pfl. 1¹: 235. 1897) regards them as synonyms. Saccardo treats the genera as distinct but the characters on which they are separated by him are vague and the basis for separation not clearly defined.

In working over the various species of the two genera the writer has been inclined to throw them together in one genus, since it seems to be impossible to separate them on ascospore characters. However, more detailed study has revealed an apparently definite morphological character on which the genera can be separated if we wish to resort to the conidial stages. To what extent the conidial stage should be used in segregating genera of the Ascomycetes is an open question since the latter are often obscure or entirely wanting. Fortunately, however, there are usually other characters which accompany the differences in conidial characters by which species can be distinguished even though the conidial stage is not actually seen. Such seems

¹ This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

to be the case with *Dermea* and *Pezicula* so far as our observations have gone.

Dermea has a conidial stage, usually accompanying the apothecial, consisting of soft fleshy stromata with irregular cavities in which pynospores are produced. The pynospores are long, fusiform, and usually curved resembling those of the genus *Fusarium*. Such forms have usually been referred to *Micropera* or *Gelatinosporium*. On the other hand, *Pezicula* has conidia of a very different type, being large and ellipsoid and borne on the outside of a fleshy stroma. The conidial stage of this type has been referred to various form genera, *Gleosporium*, *Myxosporium*, *Discosporium* and *Tuberculariella*. Or the conidia may be produced in well developed pycnidia of somewhat variable form. These are usually referred to *Sphaeronema*.

Fortunately there seems to be some apothecial characters which accompany these conidial differences. The apothecia in *Pezicula* are soft and fleshy and usually light-colored, yellowish or whitish, the hymenium being plane or convex and more or less roughened by the paraphyses which seem to be entirely free. In *Dermea* on the other hand the apothecia are dark-colored and the hymenium dark-brown or blackish and presenting a smooth surface. The paraphyses are bound together by a dark matrix forming a rather definite epithecium. Whether these apothecial differences will hold throughout the genera is not certain since the conidial stages in many of the species are unknown.

The object of the present paper is to present these differences as they appear at the present time hoping that this will stimulate new activity in the collection and study in various species of the two genera. Special search should be made by collectors for the conidial stage.

4. *DERMEA* Fries, Syst. Orbis Veg. 343. 1825.

Dermatea Fries, Summa Veg. Scand. 362. 1849.

Apothecia occurring singly or more often in cespitose clusters often on a stromatic base, tubercular in form or discoid more rarely scutellate, usually dark-colored, comparatively small, rarely exceeding 2 mm. and usually 1 mm. or less in diameter, coriaceous to subcarbonaceous; asci usually broad-clavate and 8-spored; spores usually comparatively large, occasionally minute,

simple or becoming tardily 1-several-septate, the septation often erratic even in the same species; paraphyses colored and their tips agglutinated into a dark-brown or blackish epithecium.

Type species, *Peziza Cerasi* Pers.

This genus grades rather closely into *Cenangium* but usually has smaller discoid apothecia and larger often septate spores. The pycnospores in the various species which are produced in irregular pycnidial cavities in a fleshy stroma are fusiform, usually curved and septate. The conidial stage so far as observed belongs to the form genus *Micropera* (*Gelatinosporium*).

DERMEA CERASI (Pers.) Schw. Trans. Am. Phil. Soc. II. 4: 237. 1832.

Peziza Prunastri Pers. Tent. Disp. Fung. 35. 1797.

Peziza Cerasi Pers. Tent. Disp. Fung. 35. 1797.

? *Sphaeria dubia* Pers. Ic. Pict. Fung. 48. 1806.

Ceratostoma spurium Fries, Obs. Myc. 2: 338. 1818.

Cenangium Cerasi Fries, Syst. Myc. 2: 179. 1822.

Cenangium Prunastri Fries, Syst. Myc. 2: 180. 1822.

Micropera drupacearum Lév. Ann. Sci. Nat. III. 5: 283. 1846.

Dermatea Cerasi Fries, Summa Veg. Scand. 362. 1849.

Dermatea Prunastri Fries, Summa Veg. Scand. 362. 1849.

Micropera Cerasi Bonord. Abh. Nat. Gesells. Halle 8: 133. 1864.

Sphaeronema spurium Sacc. Syll. Fung. 3: 186. 1884.

Tympanis Prunastri Wallr. Fl. Crypt. Germ. 2: 427.

Tympanis Cerasi Quél. Enchir. Fung. 330. 1886.

Apothecia bursting through the bark in dense cespitose clusters often 1 cm. in length and usually much narrower, the individual apothecia at first club-shaped discoid, with a thick stem-like base, reaching a diameter of 1 mm., about as high as broad, brownish-black; hymenium plane or nearly so, black; asci clavate, reaching a length of 80–100 μ and a diameter of 12 μ , 8-spored; spores irregularly 2-seriate, ellipsoid, becoming 1-septate, straight or slightly curved, 5–7 \times 15–18 μ (rarely as long as 20 μ); paraphyses filiform, the ends forming a brown epithecium.

Often accompanied by the conidial stage, consisting of soft yellowish stromata with pycnothecial cavities or often forming conical pycnidia 1–3 mm. high; pycnospores fusiform-linear, curved, hyaline, 3.5 \times 40–50 μ .

On branches of *Prunus emarginata*, *Prunus pennsylvanica* and other species of *Prunus*.

TYPE LOCALITY: Europe.

DISTRIBUTION: Pennsylvania to Newfoundland; also in Europe.

ILLUSTRATIONS: Phill. Brit. Discom. *pl.* 10, *f.* 66; Phytologist 12: 211, *f.* 3 (as *Dermatella Prunastri*); ? Pers. Ic. Pict. Fung. *pl.* 20, *f.* 1-2; Tul. Fung. Carp. 3: *pl.* 19, *f.* 13-17; E. & P. Nat. Pfl. 1¹: 237, *f.* 179 A-D; Rab. Krypt.-Fl. 1³: 242, *f.* 1-6.

EXSICCATI: N. Am. Fungi 40, 989, 2555, 2812; Fungi Columb. 3118, 4942; Reliq. Farlow. 113; Rav. Fungi Am. 2116; Rav. Fungi Car. 71.

According to W. J. Dowson (Phytologist 12: 207. 1913) causing a disease of greengage plum trees in England.

DERMEA BETULAE Rehm in Rab. Krypt.-Fl. 1³: 1221. 1896.

Gelatinosporium fulvum Peck, Ann. Rep. N. Y. State Mus. 38: 97. 1885.

Apothecia usually occurring singly erumpent through the bark and becoming prominent, externally yellowish brown, reaching a diameter of 1 mm.; hymenium nearly plane with an upturned margin, black or blackish; asci clavate reaching a length of 90 μ and a diameter of 16-18 μ , 8-spored; spores irregularly 2-seriate narrow-ellipsoid, at first 1-septate, often becoming 3-septate, 5-7 \times 14-20 μ ; paraphyses slender, enlarged above, the apices surrounded by a brown matrix which forms a dark epithecium.

Conidial stage, *Micropera*, consisting of an erumpent yellowish stroma, with irregular pycnothecial cavities from which the spores ooze in a gelatinous mass, pycnospored fusiform, curved, 3-septate 3-4 \times 55-75 μ , hyaline.

On branches of *Betula lutea* and *Betula* sp. and *Alnus* sp.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Nova Scotia and Michigan; also in Europe.

The writer has examined what is apparently a part of the type material *Gelatinosporium fulvum* and finds that it agrees with the *Micropera* which accompanies this species and is apparently its conidial stage.

***Dermea Brenckleana* (Sacc.) Seaver, comb. nov.**

Patinella Brenckleana Sacc. Mycologia 12: 203. 1920.

Apothecia gregarious, erumpent-superficial, occurring either singly or in cespitose clusters of several each, brownish-black, becoming subdiscoïd, reaching a diameter of 1 mm.; hymenium slightly concave or plane with the margin slightly elevated, brownish-black, a little darker than the outside of the apothecium; asci clavate, reaching a length of $70\ \mu$ and a diameter of $11\text{--}12\ \mu$, 8-spored; spores 2-seriate, fusoid, slightly curved $3\text{--}4 \times 15\ \mu$ (septate ?); paraphyses filiform, hyaline.

The conidial stage consists of fleshy stromata in the cavities of which typical pycnosporos are produced. The pycnosporos are fusiform, curved and reach a diameter of $2\text{--}3\ \mu$ and a length of $16\text{--}18\ \mu$, and are apparently 1-septate.

On *Amelanchier alnifolia*.

TYPE LOCALITY: Whitestone Gully, North Dakota.

DISTRIBUTION: North Dakota and Montana.

The *Micropera* stage of this fungus was found associated with the apothecia in type material obtained from Dr. J. F. Brenckle. Both stages were also found on bark of *Amelanchier alnifolia* from Montana which was collected by Dr. J. R. Weir (14921) but apparently not seen by him, since it bore also *Sphaeronema pruinosa* Peck for which it was collected. The latter is the conidial stage of *Pezicula pruinosa* (Peck) Farlow.

PEZICULA Tul. Fung. Carp. 3: 182. 1865.

Apothecia usually occurring in cespitose clusters on a stromatic base, sessile or with a short thick stem-like base, usually light colored whitish or yellowish, rarely exceeding 1 mm. in diameter, tubercular or discoïd, usually soft and fleshy; asci broad-clavate, usually 8-spored; spores ellipsoid, simple or becoming tardily 1-several-septate; paraphyses hyaline or subhyaline and usually free, not agglutinated and not usually forming an epithecium.

Type species, *Peziza carpinea* Pers.

The genus is distinguished from *Dermea* by the light colored fleshy apothecia and the character of the conidial stage. The pycnosporos are broad-ellipsoid and borne externally on the surface of the stroma, *Myxosporium*, or in well developed pycnidia, *Sphaeronema*.

PEZICULA CARPINEA (Pers.) Thüm. Fungi Austr. 767. 1873.

? *Tubercularia fasciculata* Tode, Fung. Meckl. 1: 20. 1790.

Peziza carpinea Pers. Syn. Fung. 673. 1801.

Cyclodum Carpini Wallr. Fl. Crypt. Germ. 2: 512. 1833.

Dermatea carpinea Fries, Summa Veg. Scand. 362. 1849.

Apothecia thickly gregarious, springing in caespitose clusters from an immersed fleshy stromatic base, the individual apothecia tuberculate or expanded and subdiscoid, with a short stem-like base, often distorted by mutual pressure, reaching a diameter of 1–3 mm., yellowish; hymenium plane or convex, similar in color to the outside of the apothecium; asci clavate, reaching a length of 150–200 μ and a diameter of 15–20 μ , 8-spored; spores ellipsoid, straight or curved, granular within, for a long time simple but often becoming 1–3-septate, 10–12 \times 18–30 μ ; paraphyses slender, branched, enlarged above, reaching a diameter of 5 μ , not forming an epithecium.

The conidial stage of this species as pointed out by Tulasne consists of a soft fleshy stroma on the surface of which the pycnospores are produced. Pycnospores broad-ellipsoid 10–12 \times 20–24 μ , each borne on a slender conidiophore which is strongly swollen just below the point of attachment.

On trunks and branches of *Carpinus caroliniana*.

TYPE LOCALITY: Europe.

DISTRIBUTION: Massachusetts to Missouri and Pennsylvania; also in Europe.

ILLUSTRATIONS: ? Tode Fungi Meckl. pl. 4, f. 32; Rab. Krypt.-Fl. 1³: 243, f. 1–6; Ann. Sci. Nat. III. 20: pl. 16, f. 17, 18.

EXSICCATI: N. Am. Fungi 67 b (as *Dermatea carnea*), 3333; Shear, New York Fungi 93; Rab.-Winter, Fungi Eu. 3463; Reliq. Farlow. 134.

PEZICULA ACERICOLA (Peck) Sacc. Atti. Ist. Veneto VI. 3: 725. 1885.

? *Peziza cinnamomea* D.C. in Pers. Myc. Eu. 1: 268. 1822.

Sphaeronema acerinum Peck, Ann. Rep. N. Y. State Mus. 24: 86. 1872.

Nodularia acericola Peck, Ann. Rep. N. Y. State Mus. 25: 98. 1873.

Dermatea carnea Cooke & Ellis, Grevillea 5: 32. 1876.

Sphaeronema nigripes Ellis, Bull. Torrey Club 6: 107. 1876.

Tympanis acerina Peck, Ann. Rep. N. Y. State Mus. 31: 48. 1877.

? *Dermatea cinnamomea* Phill. Brit. Discom. 342. 1887.

Scleroderris acerina Sacc. Syll. Fung. 8: 599. 1889.

Dermatea acericola Rehm in Rab. Krypt.-Fl. 1³: 1245. 1896.

Apothecia erumpent in cespitose clusters of 3–8 each, the individuals seldom exceeding 1 mm. in diameter sessile or subsessile, pale-yellow (becoming blackened with age); hymenium plane or slightly convex, the margin rather indistinct, similar in color to the outside of the apothecium, becoming concave with age; asci clavate, reaching a length of 90–130 μ and a diameter of 15–20 μ , 4–8-spored, gradually tapering below into a slender stem-like base; spores irregularly 2-seriate above, ellipsoid, straight or curved, at first simple, often becoming 3–4-septate, 8×24 –26 μ , hyaline or subhyaline, occasionally septate; paraphyses slender, enlarged above and often flexuose hyaline or slightly colored with age.

This species is associated with *Sphaeronema acerinum* Peck which appears to be its conidial stage. Pycnidia minute, black with long, bristle-like, translucent ostiola. Pycnosporos broad-ellipsoid, 8×20 μ slightly narrowed at the point of attachment with the conidiophore which equals or exceeds the length of the spore and is slightly swollen just below the point of attachment.

On dead branches of *Acer rubrum* and other species of *Acer*.

Type locality: North Elba, New York.

DISTRIBUTION: New York and Pennsylvania to Newfoundland and Ontario.

ILLUSTRATIONS: Grevillea 5: pl. 75, f. 9 (as *Dermatea carnea*).

EXSICCATI: Reliq. Farlow. 112, 143 a–b; Thüm. Myc. Univ. 978; Rehm, Ascom. 1901; Ellis, Nova-Caesar. 56 (as *Dermatea carnea*); N. Am. Fungi 67a; Fungi Columb. 3420.

In working over recent collections of *Dermatea acericola* the writer found *Sphaeronema acerinum* Peck intimately associated with them and arrived at the conclusion that this represented the conidial stage of *Dermatea acericola*. Later, however, in looking over the literature of the subject it was discovered that *Sphaeronema acerinum* had been listed by Peck and others as the conidial stage of *Tympanis acerina* in which the apothecia are entirely black and quite different in general appearance from *Dermatea acericola*. This prompted a more careful scrutinizing of the two species and it was discovered that *Tympanis acerina* Peck is merely an aged and blackened form of *Dermatea acericola*. Even in material collected by Peck, which is apparently part of

the type of *Tympanis acerina*, a few of the yellow apothecia were found. In later collections the yellow and the black apothecia were also found intimately associated (see Reliq. Farlow. 112). Furthermore, both supposed species have asci and spores which are in every way identical leaving no doubt that the two species are synonymous. Hence both the writer and Peck were justified in their conclusions that *Sphaeronema acerinum* represents the conidial stage of the two species which are now known to be synonymous.

***Pezicula spiculata* Seaver, sp. nov.**

Apothecia cespitose in rounded or elongated clusters or rarely occurring singly, reaching a diameter of 1 mm. pale yellowish, sessile or tapering into a short stem-like base; hymenium slightly concave or plane not darker than the outside of the apothecium; asci broad-clavate, reaching a length of $120\ \mu$ and a diameter of $16\text{--}18\ \mu$, 8-spored; spores irregularly 2-seriate, ellipsoid and often slightly curved $8 \times 24\text{--}27\ \mu$, becoming 1-3-septate; paraphyses slender slightly enlarged above, the ends free, branched, hyaline, about $2\ \mu$ in diameter.

The conidial stage, *Sphaeronema*, accompanies the apothecial both springing from a floccose stroma. The pycnidia are large and spike-like, black but covered with white flakes reaching a length of 1.5 mm., swollen below. The pycnosporos are $10 \times 20\text{--}24\ \mu$ and borne on sporophores equalling or exceeding the length of the spore.

On *Acer* (*spicatum*?).

Type collected near Ithaca in connection with the summer foray, Aug. 28-Sept. 2, 1931.

So far as the ascigerous stage of this species is concerned it can scarcely be distinguished from *Pezicula acericola*. However, the two are apparently entirely distinct in their conidial stages. The *Sphaeronema* stage very closely resembles *Sphaeronema pruinosa* Peck which occurs on *Amelanchier* and is the conidial stage *Pezicula pruinosa* (Peck) Farlow.

CULTURE DATA

Pezicula acericola.

In order to prove the connection between *Pezicula acericola* (Peck) Saccardo and *Sphaeronema acerinum* Peck, culture work

was undertaken by the junior author of this paper. The work was based on collections made by the senior writer in the latter part of August and early September, 1931, in connection with the fungus foray at Ithaca, New York. Preliminary experiments showed the ascospores of this species to still be in a viable condition.

On April 6, 1932 a single ascus was planted and germination was apparent the following day. On April 14, 1932 four single spore test tube cultures were made on potato agar. On April 26, 1932 four more test tube cultures were made on Lindegren agar and growth was much more luxuriant than on the potato agar. Many greenish bodies formed some with yellowish growth at the tips. On May 15, 1932 a small white powdery looking growth on plate planted April 7, 1932 was examined and conidia were found abundantly which agreed with the conidia found in *Sphaeronomema acerinum*. These are at first simple later appear to becoming 1-3-septate or pseudo-septate not apparent in material collected on natural substratum.

While the spores were found in greenish bodies these bodies

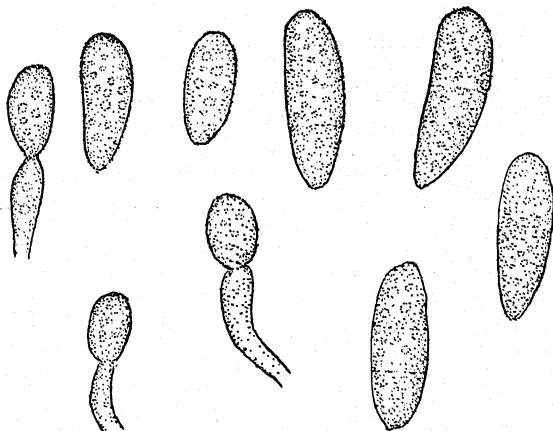


FIG. 1. *Pezicula acericola*. Pycnospores from culture.

did not take on the form of the pycnidia found in nature. They entirely lacked the long filiform ostiole. However, this is probably reaction to substratum since the spores themselves appear to be typical (FIG. 1).

Pezicula spiculata.

This species here designated as new was based on material collected at the same time and the same place as the preceding, *Dermatea acericola*. The pycnidial stages as they occur in nature are so distinct that the writer is inclined to regard them as different species.

In order to demonstrate, if possible, these differences in culture the spores of this species were cultivated simultaneously with *Dermatea acericola* with similar results. However, in neither case did the pycnidia develop sufficiently to show the characteristics that appear in nature.

Unfortunately these experiments were cut short owing to the fact that the junior author returned to Porto Rico early in June. More cultural work should be carried on in order to demonstrate the points brought out above.

THE NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATES

PLATE 20

Upper figure (1). *Dermea Cerasi*. In the center photograph of branch showing apothecia (about natural size) with enlarged sketch of an apothecium and stromata above. To the right drawing of ascus and paraphyses. Below sketch of stromata and pycnosporos.

Lower figure (2). *Dermea Brenckeleana*. In the center photograph of branch showing apothecia from type material (about natural size). Above large drawing of apothecia. To the left an ascus with spores and paraphyses. Below sketch of stroma and pycnosporos.

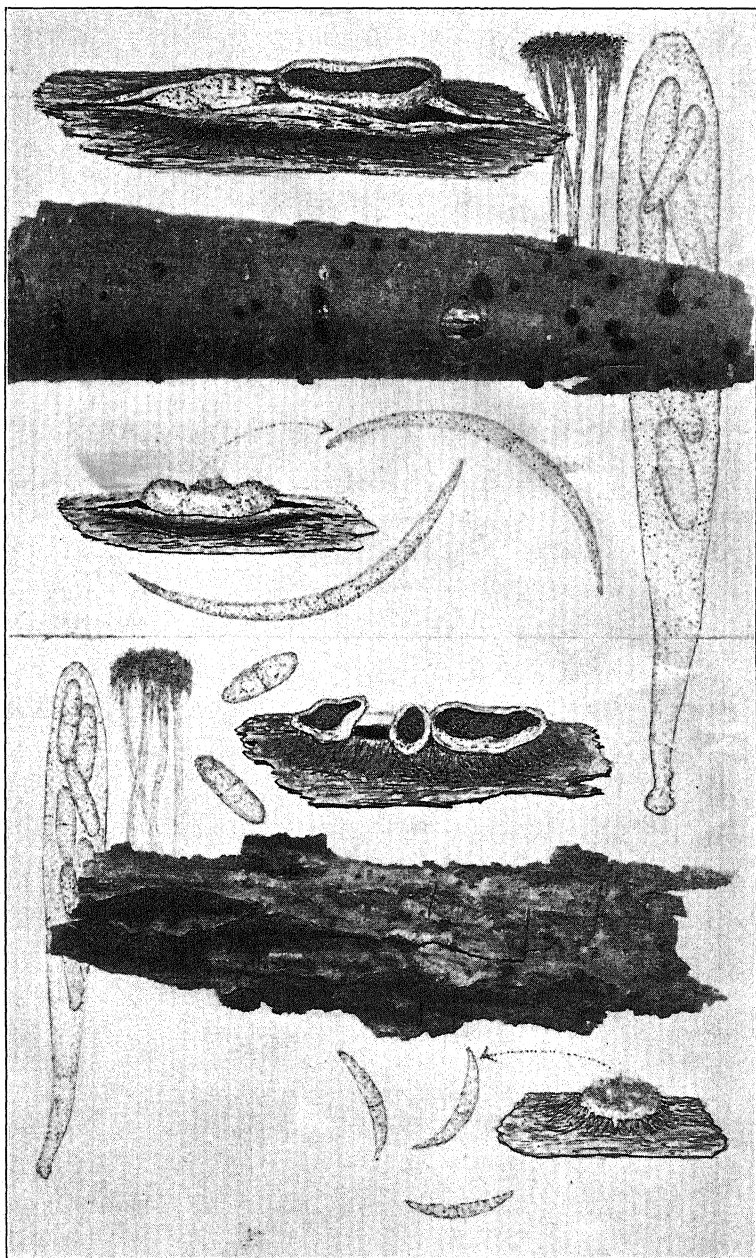
PLATE 21

Upper figure (1). *Dermea Betulae*. Photograph of twigs of *Betula lutea* showing apothecia (about natural size). Above enlarged sketch of apothecia. To the left an ascus with spores and paraphyses. In the center sketch of a stroma and pycnosporos.

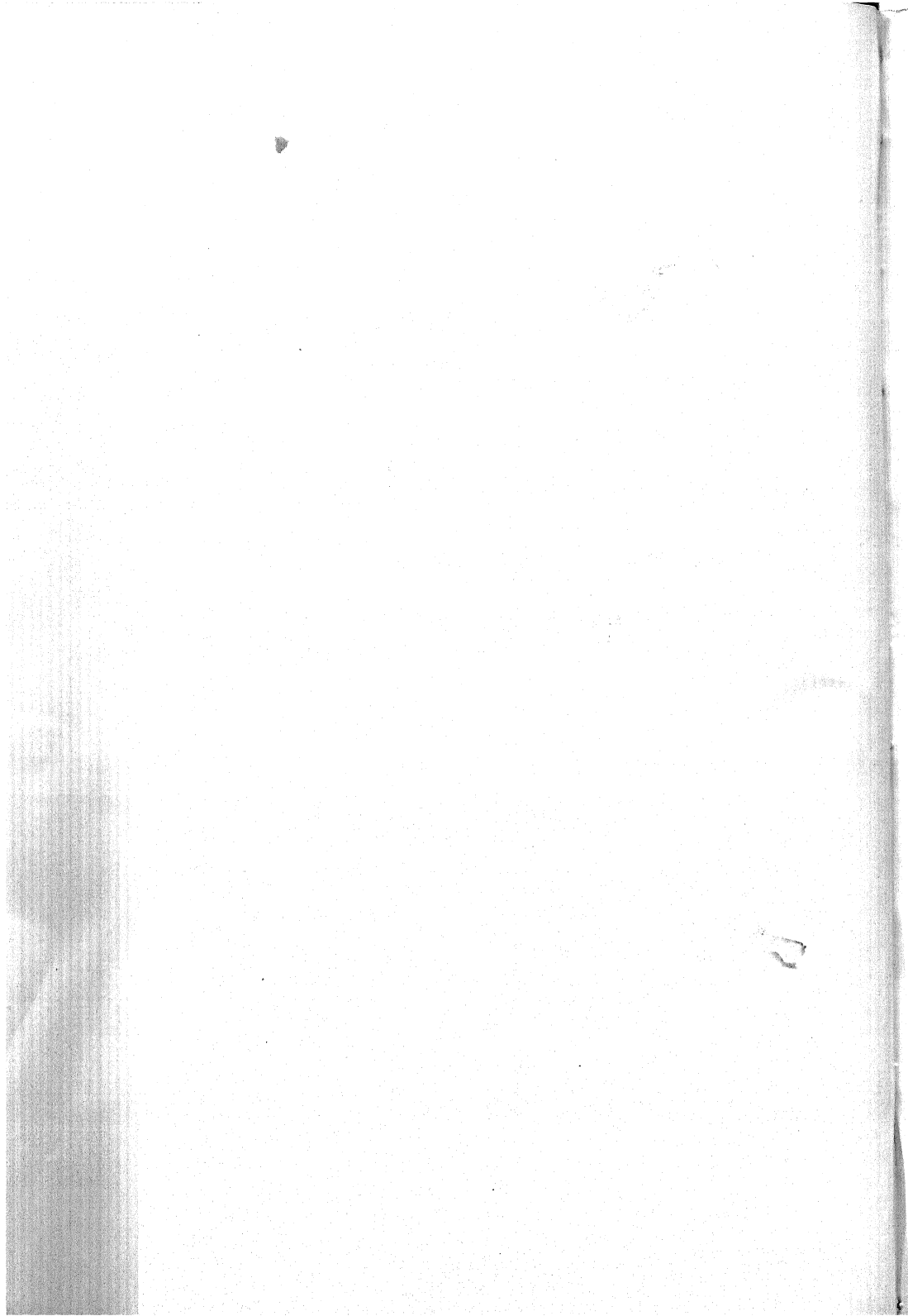
Lower figure (2). *Dermea Betulae*. In the center photograph of branch of *Alnus* showing apothecia (about natural size). Above enlarged sketch of an apothecium and stromata. To the right an ascus with spores and paraphyses. Below pycnosporos.

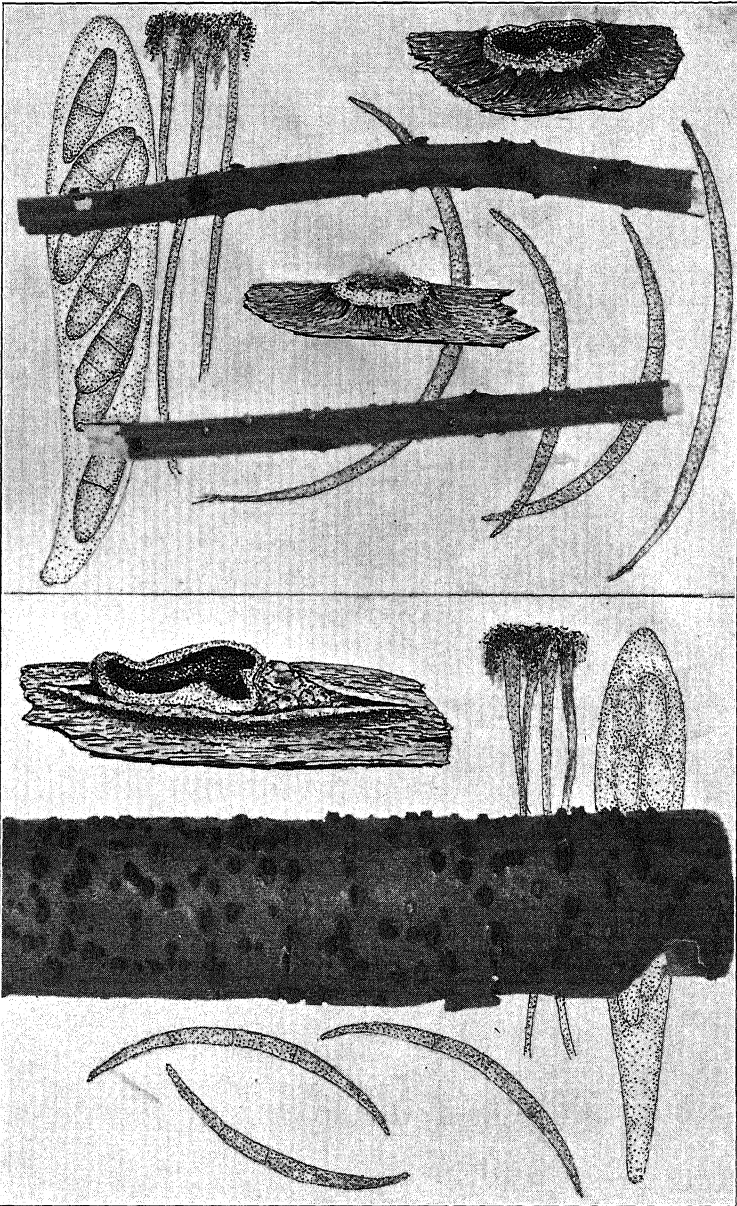
PLATE 22

Pezicula carpineae. Photograph of branch showing apothecia (considerably reduced). To the left sketch of apothecia with an ascus with spores and paraphyses. To the left pycnosporos in various stages of development.

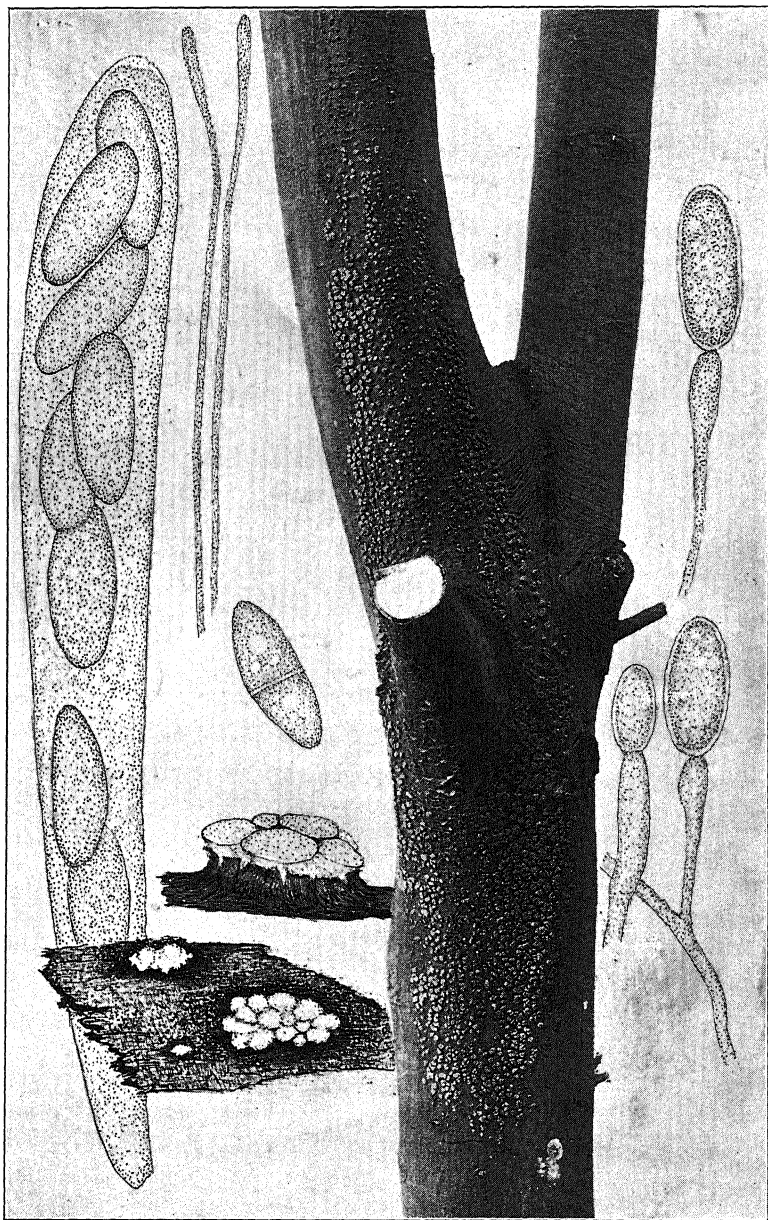


DERMEA CERASI
DERMEA BRENCKELEANA

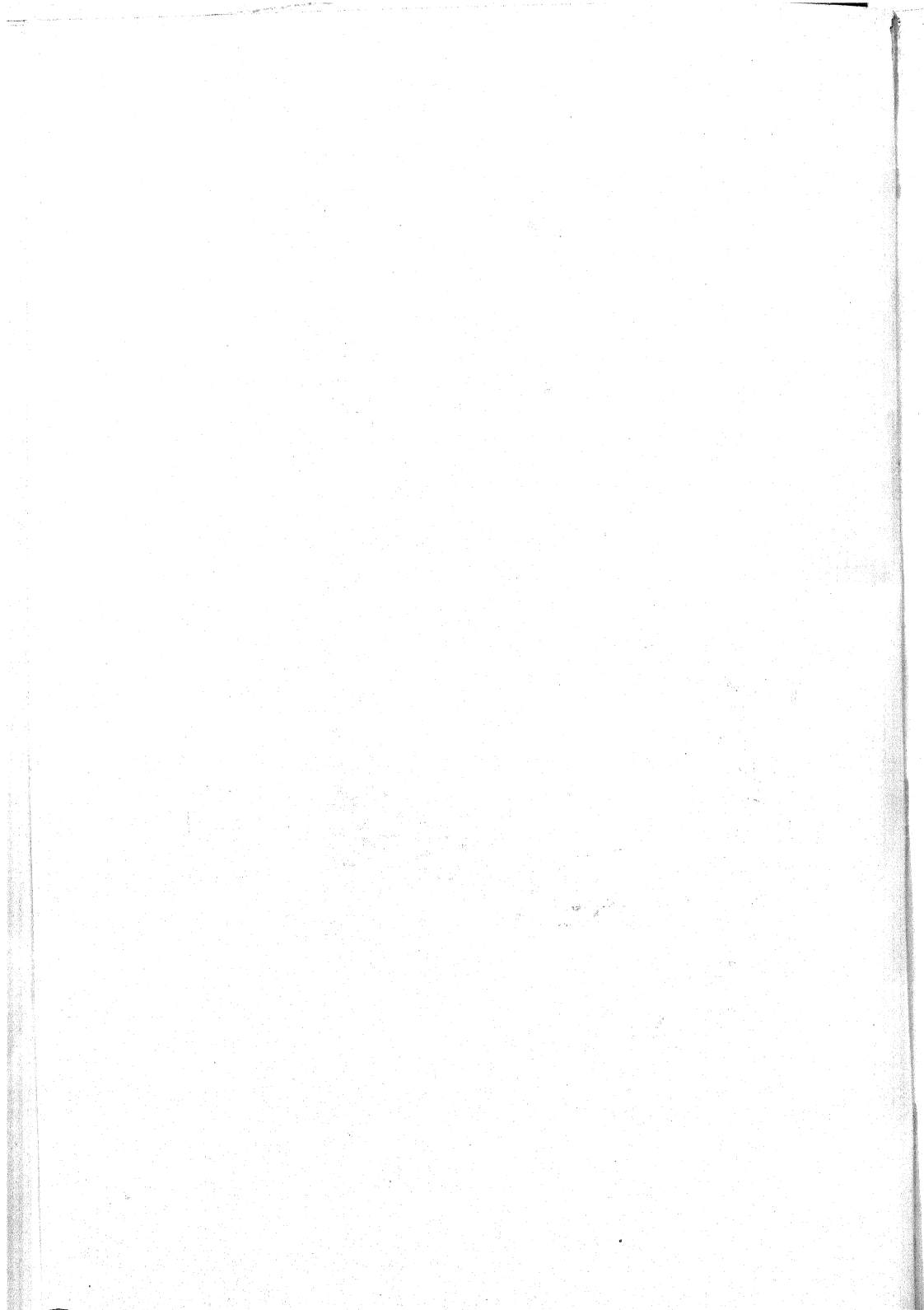


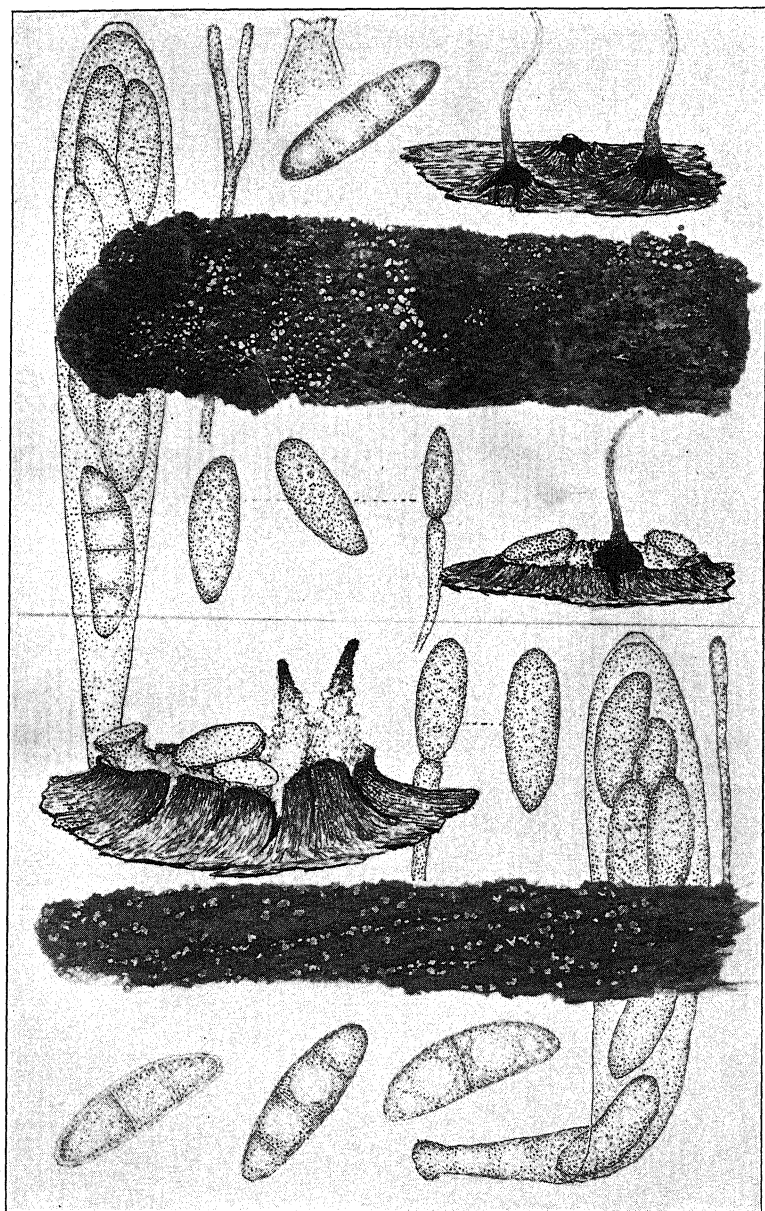


DERMEA BETULAE



PEZICULA CARPINEA





PEZICULA ACERICOLA
PEZICULA SPICULATA

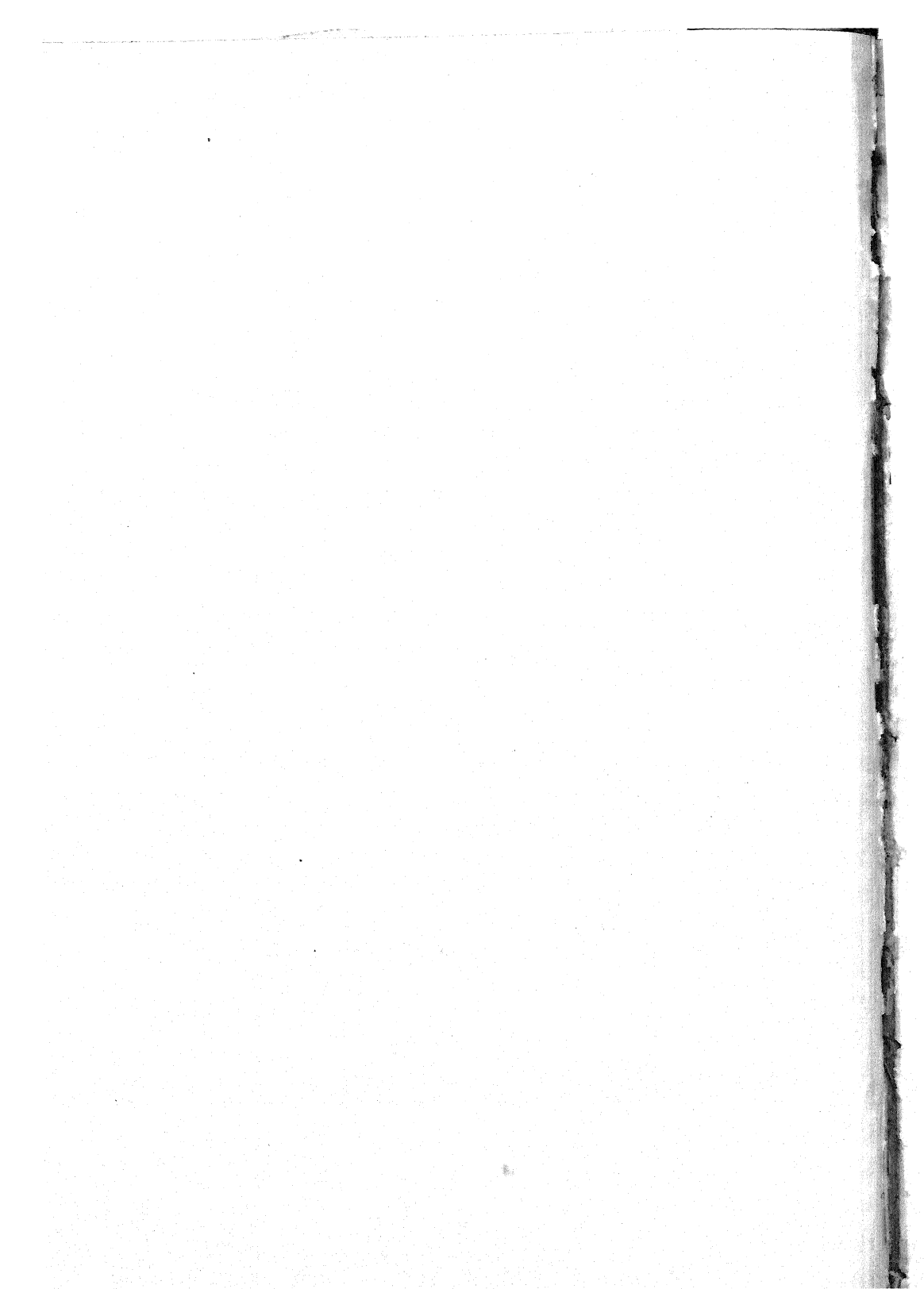


PLATE 23

Upper figure (1). *Pezicula acericola*. Near the center photograph of bark showing apothecia (about natural size). To the left an ascus with spores and paraphysis and the end of a ruptured ascus. Upper right hand corner sketch of *Sphaeronema acericola*. Lower right hand corner stroma showing both apothecial and conidial stages produced on the same stroma.

Lower figure (2). *Pezicula spiculata*. Near the center photograph of bark showing apothecia and pycnidia (about natural size). Upper left hand corner sketch of stroma showing apothecia and pycnidia with pycnosporos. Right hand side an ascus with spores and paraphysis. Below drawing of mature ascosporos.

Note: All drawings of ascosporos and pycnosporos are made with a one inch eye piece and a one-eighth objective and drawn with the aid of a camera lucida.

NOTES AND BRIEF ARTICLES

THE LIFTING POWER OF A MUSHROOM

(WITH ONE TEXT FIGURE)

An astonishing phenomenon exhibited by a fungus was witnessed by many persons on August 7 and 8, 1932, when a field mushroom—*Agaricus arvensis*—pushed up through the asphalt pavement in a drive on Wabash College campus, Crawfordsville, Indiana. This drive was paved in 1930. A gravel road bed

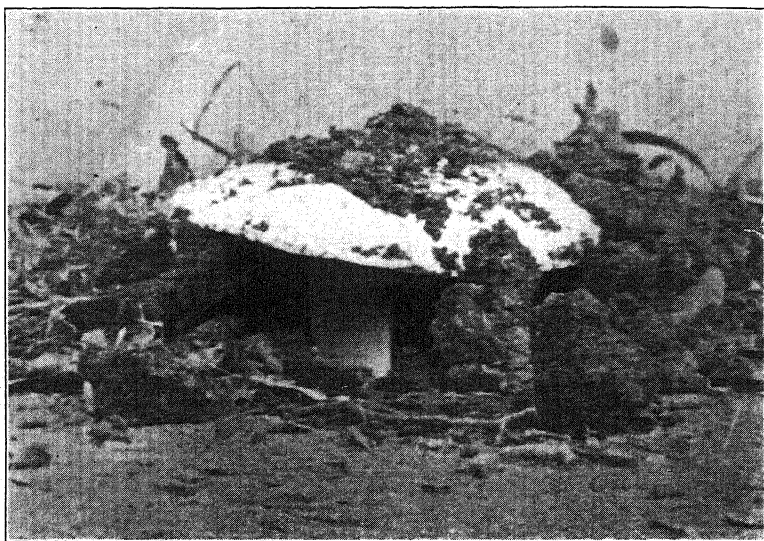


FIG. 1. Lifting power of a mushroom.

topped with about three inches of Kentucky asphalt was subjected to a steam roller. This covering did not seem to phase the mushroom. The photograph shows that it is a normal specimen. The debris on and lying about the mushroom is asphalt and cork from a nearby sycamore tree.—A. R. BECHTEL.

WABASH COLLEGE,
CRAWFORDSVILLE, INDIANA.

Urocystis Heucherae sp. nov.

Sori in the leaves and petioles, more or less distorting them, at first covered with a whitish membrane which when ruptured discloses a black powdery mass of spores; spore balls variable in size, 17–42 μ , averaging 25 μ in diam., mostly spherical or sub-spherical, usually with 3 to 4 spores; the cortex of sterile cells usually completely covering the spores; sterile cells spheroidal, with nearly hyaline walls about 4 μ diam., spores ellipsoidal to rounded-triangular, reddish brown or darker, averaging about 12 μ in diameter.

On *Heuchera parvifolia* Nutt. Collected by A. O. Garrett, Glacier Cirque below Emerald Lake, Mt. Timpanagos, Wasatch Mts., Utah Co., Utah, August 8, 1927 (Garrett Herb. No. 3378). The *Heuchera* was also badly infected with *Puccinia curtipes* Howe.

Only one other smut, *Urocystis Lithophragmae* Garrett, has been described on a member of the Saxifragaceae which is distinguished from *U. Heucherae* by having smaller, more regular spore balls with from 1–2 spores.

A. O. GARRETT

EAST HIGH SCHOOL,
SALT LAKE CITY, UTAH

TRANSLATION OF TULASNES' CARPOLOGIA

Mycologists owe a debt of gratitude to Doctors A. H. R. Buller and C. L. Shear for making available the English translation by W. B. Grove of the three volumes "Selecta Fungorum Carpologia" of the Tulasne brothers, L. R. and C. Tulasne.

The translation and publication of this work was made possible through the financial assistance of Dr. Howard A. Kelly of Baltimore; James Richardson and Max Steinkopf of Winnipeg; T. B. Macaulay of Montreal; and E. W. Mason of Kew, England. The original copperplate illustrations have been reproduced by collotype.

The Carpologia was one of the outstanding works of its time, its purpose being to demonstrate the pleomorphism of the Ascomycetes. It is invaluable to students of this group. Even though the work was available the Latin was so difficult that it was out of the reach of the average student. Since its translation

and publication entailed a heavy financial outlay, mycologists should coöperate in the enterprise by securing the work for their various institutions. Details may be had from the Editors, Doctors A. H. R. Buller and C. L. Shear.—F. J. SEAVER.

THE MYCOLOGICAL SOCIETY OF AMERICA

CONSTITUTION

(Adopted by the Society, December 28, 1932, at Atlantic City, New Jersey.)

ART. 1. *Name.* The Society shall be known as the Mycological Society of America.

ART. 2. *Membership.*

(1) The Society shall consist of members and may include life members, patrons, honorary members, and corresponding members.

(2) Charter membership in the Society shall consist of the persons who, after the invitation of the Secretary, joined before or during the formal organization of the Society at the Atlantic City meetings in 1932.

ART. 3. *Dues.* The dues for regular members shall be five dollars a year. Any member may become a life member by paying one hundred dollars in one payment or a patron by paying one thousand dollars, and upon election shall have all the privileges of members. Such funds obtained from life members and patrons shall constitute an endowment fund to be used as may be decided by the Council for the support of mycological publications or projects.

Annual dues of five dollars shall include subscription to the official organ of the Society, and shall be payable on or before December 20. Bills for dues shall be sent to the members in October and it will be necessary to discontinue sending the journal to those whose dues have not been paid by December 20.

ART. 4. *Membership and Election of Members.*

(1) All persons interested in the study of the fungi shall be eligible to membership.

(2) Members may be elected at any regular meeting of the Society or in the interim between meetings may be elected by the

Council. Applications for membership must be endorsed by at least one member of the Society.

ART. 5. *Officers.* The officers of the Society shall consist of a President, Vice-president, and Secretary-Treasurer, whose duties shall be those usually performed by such officers. The President and Vice-president shall serve for one year and the Secretary-Treasurer for three years (or until their successors are elected). Any vacancies occurring in the interim between elections shall be filled by the Council.

The Council shall consist of the President, Vice-president, Secretary-Treasurer, and two Councillors. The Councillors shall be elected, one each year, to serve for a term of two years.

ART. 6. *Editors and Committees.* The editors of the official journal of the Society shall be elected by the Council. The President shall appoint all temporary committees that are to serve during his administration and shall fill all vacancies on standing committees that may occur during his term of office.

ART. 7. *Election of Officers.* The Secretary-Treasurer shall send to each member of the Society in October a ballot for the nomination of officers. All nominations are to be returned by November 15. If any nominations are lacking, the Council shall have power to make them. The three candidates for each office receiving the highest number of nominating votes shall be placed upon a final ballot to be sent to each member December 1. Votes shall be mailed to the Secretary-Treasurer and counted by the Council. A plurality vote shall elect.

ART. 8. *Meetings.* An annual meeting shall be held at such time and place each year as the Council may select (usually in connection with the A.A.A.S. meetings). An additional meeting for informal discussion and the carrying out of collecting forays shall be held in the summer or autumn at a time to be selected by the Council. Additional meetings, including special or local meetings for the presentation of papers or the carrying out of forays, may be arranged by the Council at its discretion.

ART. 9. *Divisions.* Branch organizations or units within the Society known as Divisions, may be established on a geographical basis provided formal application, setting forth the reasons for the establishment of the Division, is made to the parent Society and approved by it.

ART. 10. *Journal.* The Society shall adopt or establish a journal which shall serve the Society as its official organ primarily for the publication of mycological papers by its members, for the publication of abstracts of the papers delivered at the annual or other meetings, and for the publication of the report of the Auditing Committee or of other reports, announcements, and business of the Society.

ART. 11. *Amendments.* These articles may be amended by a majority vote of the members voting at any regular meeting of the Society, provided that suggested amendments have been brought to the attention of the Council of the Society in time to be sent to all of the members at least one month previous to the meeting.

BY-LAWS

1. *Programs.* Programs for annual or other meetings shall be arranged by the Council.

2. *Papers.* Members wishing to present papers at the annual meeting shall submit to the Secretary-Treasurer the substance and conclusions of the papers in a clear and concise abstract of not more than 200 words. These shall be due on or before November 15 and the Secretary-Treasurer shall be authorized to refuse any received after that date. These abstracts will be edited by the editorial committee of the official journal of the Society for subsequent publication in that organ. Members are urged not to submit titles or abstracts unless they expect to attend the meetings. Except by invitation no member shall offer more than two papers at any one meeting, papers of joint authorship being attributed to the author reading the paper.

3. *Associates.* Students and others not yet members of the Society may attend meetings and forays in the status of Associates, provided they are recommended to the Council by a member of the Society and pay a fee of one dollar. Such Associates, as they are not members, shall not have the privilege of voting and shall not receive the official journal of the Society, but shall enjoy the other privileges of the meetings and forays including the right to present one paper on the program.

4. *Auditing.* At each annual meeting the active president shall appoint an auditing committee to audit the accounts of

the Society and of its official publication. An audited statement shall be published in the official organ of the Society.

5. *These rules may be amended* by a majority vote of the members voting at any regular meeting of the Society, provided that suggested amendments have been brought to the attention of the Council of the Society in time to be sent to all the members at least one month previous to the meeting.

NOTE

At the business meeting at Atlantic City the Society voted that the question of the desirability of printing abstracts be referred to the editorial board for report back to the Society at the next annual meeting. This was followed by unanimous approval of a motion that the editorial board be advised that it was the sense of the meeting that abstracts be not published.—H. M. FITZPATRICK, Secretary-Treasurer.

CONTRACT WITH THE NEW YORK BOTANICAL GARDEN

(Accepted by the Society, December 28, 1932, at Atlantic City, New Jersey.)

The Mycological Society of America hereby adopts *Mycologia* as its official organ on the following terms:

1. *Mycologia* will continue to be published by the New York Botanical Garden, the editorial policies to be determined by an Editorial Board, consisting of a Managing Editor appointed by the New York Botanical Garden, and five Editors elected by the Mycological Society of America. The term of office of the five elected editors will be five years, except that at the start they will be designated to serve one to five years respectively. One editor will be elected annually, thereafter, to fill the place of each retiring editor.

The six members of the Editorial Board will elect an Editor-in-Chief from among their number. He will be eligible for repeated re-election. Final decision of all questions of editorial policy will be made by him, except that the Managing Editor will have full authority in all matters pertaining to the finances of the journal.

2. All personal subscribers now receiving *Mycologia* may become members of the Mycological Society of America if they so desire. Institutional subscribers to *Mycologia* are not to be regarded as members of the Society.

3. All members of the Mycological Society of America in good standing will receive *Mycologia*. In return the Society will transmit to the New York Botanical Garden, through the Managing Editor four dollars per year for each such member.

4. The New York Botanical Garden agrees to spend on the publication and distribution of *Mycologia* all funds received from subscriptions, as well as all funds transmitted by the Mycological Society of America. The Garden further agrees to use for these purposes all sums received from the sale of those volumes of the journal which shall be published after this contract is put in force. Earlier volumes remain the property of the New York Botanical Garden. It is understood that the journal will be used by the Garden for exchange purposes as formerly. Should the contract be terminated, it is agreed by the Mycological Society of America that all excess stock of *Mycologia* then on hand will be regarded as the property of the New York Botanical Garden.

5. The New York Botanical Garden reserves the fourth cover page to be used without charge for the advertisement of its publications, including *Mycologia*. The other three cover pages will be used by the Mycological Society of America as it may see fit. All sums collected from paid advertising will be expended on the journal.

6. This contract may be altered at any time by mutual agreement of the New York Botanical Garden and the Mycological Society of America. It may be terminated at the end of any calendar year on six months' written notice should it prove unsatisfactory to either party concerned.

7. The contract goes into effect at the beginning of the calendar year 1933.



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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XIX

THE CABBAGE-HEAD FUNGUS

FRED J. SEAVER

(WITH PLATE 24 AND 25)

In The North American Cup-fungi the writer established the genus *Durandiomyces* based on *Gyromitra Phillipsii* of Massee which has usually been regarded as a variety of *Peziza proteana*. It seemed to the writer that the plant was sufficiently well characterized to constitute a separate genus, although he has never had the privilege of collecting and studying the fungus from fresh material. Scarcely a month after this book was issued the writer received a fragment of a fungus from Mr. S. C. Edwards of Colton, California for examination. It was immediately referred to the above species. Photograph of a cross section of the material from which the fragment was obtained confirmed this determination (PLATE 25). Later the following note was supplied by Mr. Edwards:

"*Durandiomyces Phillipsii*. Specimen collected Jan. 21, 1929, San Bernardino Co., Calif. few days after a week of rain. Low, rich loam, near small stream, two feet from willow stump, plant growing at edge of outside furrow of cultivated field. About six inches under the plant, plainly visible rotted wood, yet so soft it

(MYCOLOGIA for March-April (25: 69-156) was issued April 1, 1933)

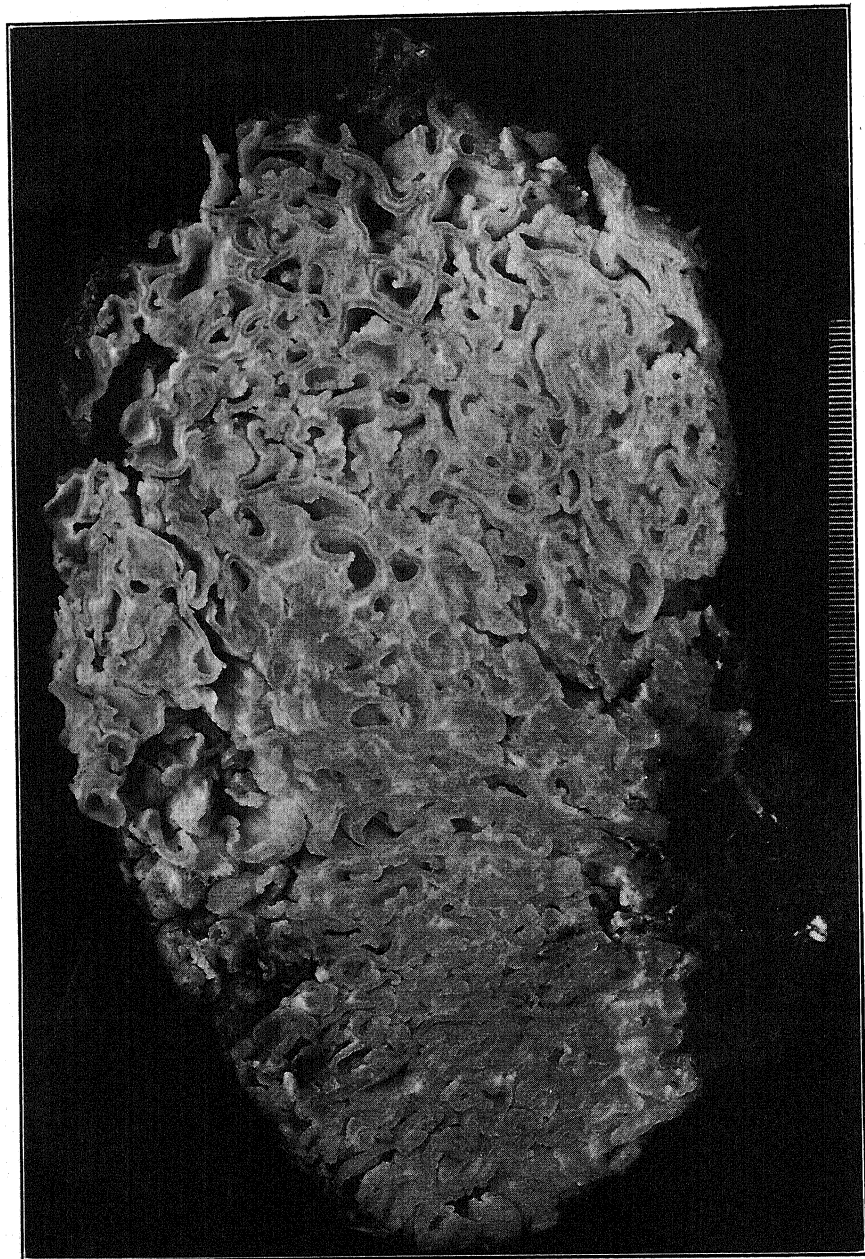
all crumbled with the earth which I dug with a sharpened stick. Could not discover whether or not the rotted wood was originally part of the willow stump. Plant had no stem, but when I returned second time to secure more details, dug out base of the sporophore large as my fist, which had broken free from the specimen originally collected. Convolutions and irregularly flattened tubes same as the specimen, only more compact. Specimen as originally found shaped much like a large, flat-head cabbage."

In March, 1931 the following additional information was obtained from Mr. Edwards: "About ten days ago I found another (I suppose) *Durandiomyces*. On willow stump in about same place as the one I found in Jan. '29. This one had gone by a little flat yet a pretty good one. Inclosed photo. Not to be returned. I think there is no doubt about its identity to the former one." (See PLATE 24.)

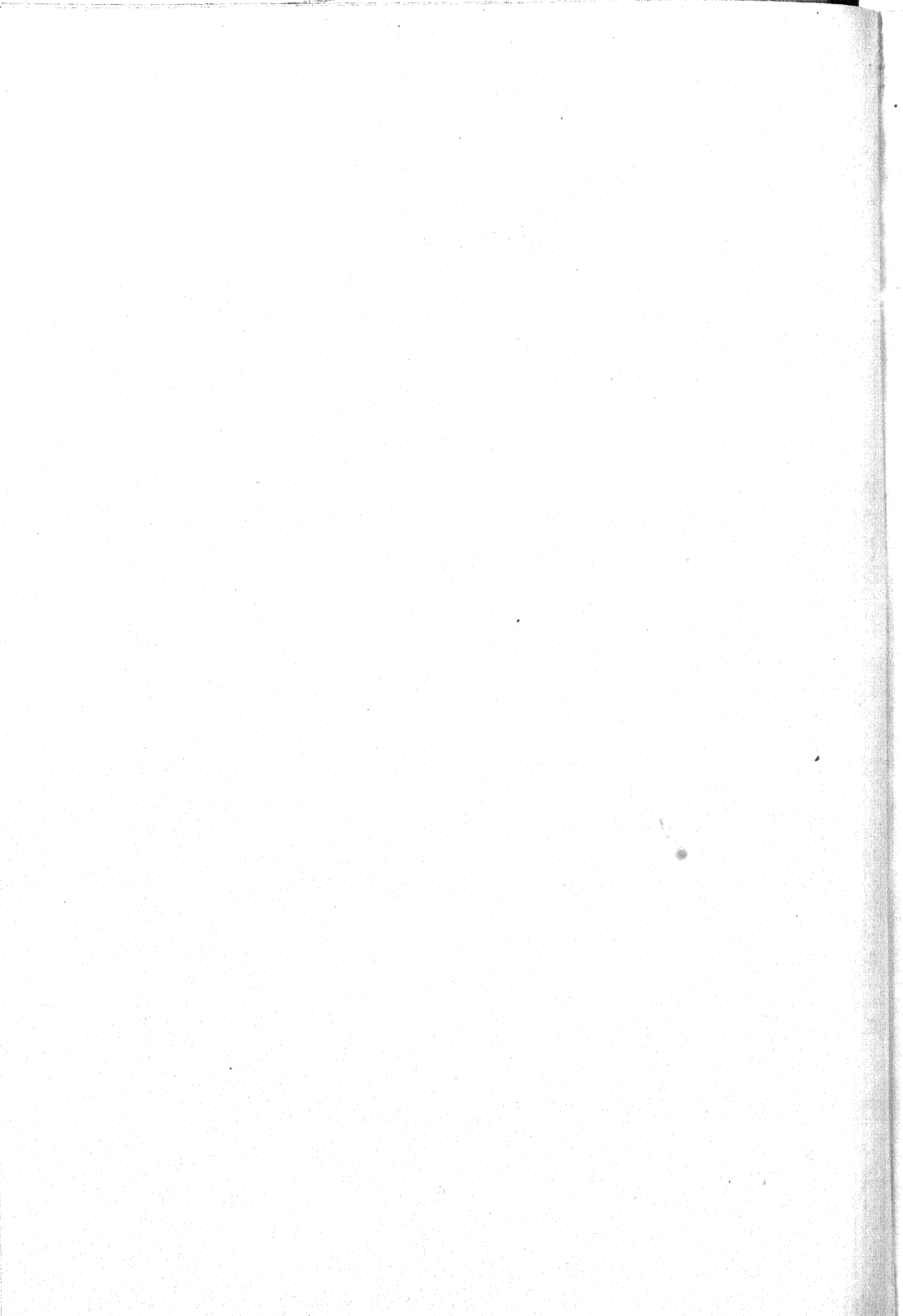
In 1931 Miss Elizabeth Morse of the California Mycological Society suggested to the writer that she believed *Durandiomyces* was identical with *Daleomyces* of Setchell, the suspicion being based on the examination of a small specimen of the latter. The genus *Daleomyces* was described in 1924 (MYCOLOGIA 16: 240) and referred to the Tuberales. This was doubtless one of the reasons why it had never been considered with the cup-fungi. Until Miss Morse so suggested, it had never occurred to the writer that there was any connection between the two species. Since the question has been raised, however, a specimen of *Daleomyces* has been examined and we find the spores identical.

Later observations by Mr. Edwards have revealed the fact that *Durandiomyces* is subhypogeous at least during its early stages. While Dr. Setchell still thinks that his plant is distinct, the evidence seems to indicate that *Daleomyces* Setchell and *Durandiomyces* Seaver are identical in which case *Daleomyces* would be adopted on the ground of priority. Since the matter cannot be absolutely decided at the present time it is perhaps just as well to leave the question open until further field evidence may be obtained.

The writer wishes to extend his thanks to Mr. S. C. Edwards and Miss Elizabeth Morse for their coöperation in securing data



DURANDIOMYCES PHILLIPSII



for this brief note. Its resemblance to a cabbage has suggested the name "cabbage-head fungus."

THE NEW YORK BOTANICAL GARDEN

EXPLANATION OF PLATES

Plate 24. Cabbage-head fungus, reduced one fourth. The head was eight inches in diameter.

Plate 25. Section through an ascophore, reduced one fourth. Photographs by S. C. Edwards.

A TAXONOMIC STUDY OF THE GENUS HYPHOLOMA IN NORTH AMERICA¹

CHAS. S. PARKER

(WITH PLATES 26-31 AND 2 TEXT FIGURES)

CONTENTS

Introduction.....	160
Historical account of the genus.....	161
Aims and methods.....	162
Phylogenetic considerations.....	165
Acknowledgments.....	168
Taxonomy of the genus <i>Hypholoma</i>	169
Key to the species.....	169
Specific descriptions.....	173
Synonyms, doubtful and excluded species.....	207
Bibliography.....	209
Index to specific names.....	210
Illustrations.....	213

INTRODUCTION

The genus *Hypholoma* belongs to the purple-brown-spored group of the Agaricaceae. In addition to the spore color, the genus is based upon the fact that the veil, breaking from the stem, leaves hair-like fibrils or a flocculose-fibrillose web or fringe pendent from the margin of the pileus. The pileus is at first with incurved margin, and is continuous with the fibrous or fleshy stem. The gills are usually adnate, sinuate and seceding. To the same purple-brown-spored series belong also the genera *Stropharia*, *Psalliota*, *Psathyra*, *Psilocybe*, and *Pilosace*. *Hypholoma* is distinguished from *Stropharia* by the absence of an annulus; from *Psalliota* by spore color and gill attachment; from *Psathyra* by the incurved margin of the pileus and the noncartilaginous cortex of the stem; from *Psilocybe* by the texture and duration of the veil; and from *Pilosace* in having a cylindric stem and attached gills.

In 1927 Dr. L. O. Overholts (15) called attention to the need for detailed studies of structure in many groups of higher fungi. In

¹ Submitted in partial fulfillment for the degree of Doctor of Philosophy, June 1932, in the Department of Botany, Pennsylvania State College.

1928 the writer undertook a critical examination of all available material in the hope of contributing to a more complete knowledge of the morphology and ecological relationship which might lead to a more satisfactory arrangement of the species within the genus *Hypholoma*.

It soon became evident that previous treatments of this group were at best incomplete and the genus greatly in need of reorganization. In fact, the American species have never been studied systematically, although local and state lists of fungi contain the names of many of the more common forms.

The lack of agreement among students of the genus as to the status of a majority of the species was a surprise and a disappointment to the writer. This confusion can no doubt be accounted for by the all too brief descriptions of the early writers, some of which were evidently based on illustrations or still older descriptions, which have proved misleading.

HISTORICAL

Persoon, Bulliard, Schaeffer and other mycologists prior to 1821 recognized certain species, subsequently referred to the genus *Hypholoma*, and either described or illustrated them, but on account of brevity or inaccuracy the literature appearing prior to 1821 has but little taxonomic value. For all practical purposes it may be said that the genus *Hypholoma* was established by Elias Fries (2) in 1821, with a brief description and quite superficial details of four species. Actually, however, this dark-spored group was treated in that and in all of his subsequent works as a subgenus of the composite genus *Agaricus* which, in his idea, more nearly represented the entire family Agaricaceae. In the *Epitome Systematis Mycologici* (1836-1838) Fries recognized sixteen species of *Hypholoma*, and these were divided, nine and seven respectively, between two characteristic divisions based upon their moisture content—hygrophanous and nonhygrophanous. In his best and most complete work, *Hymenomycetes Europaei* (1874), which has been said (8) "to represent the ripe experience and best judgment of the master," Fries conceived this genus to be composed of twenty-eight species, which he skillfully divided between five logical, if not altogether natural, sections based upon well marked and possibly unchanging characters, as follows:

Fasciculares—eight species; Viscidi—three species; Velutini—five species; Flocculosi—four species; Appendiculati—eight species. The fact that these divisions have been used in whole or in part by nearly all subsequent students of the genus well attests their value.

About the time of and since the appearance of the *Hymenomyces Europaei* several European investigators have considerably modified the Friesian concept of the genus. Among those, who have had adherents to any considerable extent, probably Quélet (19) has most widely departed from the treatment of Fries. In 1872 Quélet recognized three sections identical with those of Fries, under which he reported twenty species, but in his later work (20) a new genus *Drosophila* was established and *Hypholoma* under which he reported nine species, along with *Psathyrella* and *Psathyra* were treated as sections or sub-genera of *Drosophila*. Peck, during his long period of service as State Botanist of New York, made a painstaking study of many collections of species of this genus. He described, as new, fifteen species and culminated his work with an excellent monograph (18) in which he recognized four of the Friesian sections and reported fifteen species as occurring in New York. Murrill (13) introduced Quélet's conception of the genus into American literature, but the multiplication of generic segregates and the resultant unfamiliar combinations have not found favor with American mycologists. Harper (5) has given us two beautifully illustrated papers on the *Hypholoma* species in the region of the Great Lakes. He attempted to demonstrate a phylogenetic relationship based on a natural grouping of closely related species with well-marked characteristics. He recognized the Friesian sections as outlined above. Kauffman (8), in great detail and with accuracy, described the species of this genus as they occur in Michigan and illustrated four of the more common ones. Various members of this genus have been described, discussed or illustrated in a number of popular publications treating of fungi, but in many cases confusion rather than clarity has resulted.

AIMS AND METHODS

The writer's investigation of the genus *Hypholoma* has been restricted to those species which occur in North America with the exception that an examination has been made of a number of

European specimens of plants which are found both in Europe and North America. Much emphasis has been placed upon the study of fresh material in the field. At first it was intended to describe only species seen and examined by the writer, but for the purpose of having a more complete survey of all the American species a few have been admitted solely on the authority cited.

Most of the previous work has emphasized only external characters such as size, form, and color, but in other genera of agarics and in certain other groups of Basidiomycetes Burt (1), Overholts (14), Lange (9) and others have recognized the importance of microscopic characters in delimiting species. No such study has previously been attempted for the genus *Hypholoma*. A combination of microscopic and macroscopic characters has given a more secure foundation for specific diagnosis than either set of characters alone could be expected to give. Macroscopic characters are best observed in fresh plants in the field and mycologists have long made use of field notes for the preservation of the records of such characters. Microscopic characters can be investigated in the dried herbarium specimens as easily as in fresh plants. The technic is simple and has been fully detailed by Overholts (16). There is no need, therefore, to enlarge upon that phase at this time. Briefly it consists in the careful microscopic study of free-hand sections of fresh or dried specimens. In the present work as in most previous instances, such studies are confined to cross-sections of the gills, although it is realized that possibly a study of internal structures of other regions might also be advantageous.

Unfortunately, the species of *Hypholoma* present microscopically no such distinct and varied characters as are displayed, for example, in the genus *Pholiota* (15). The spores are remarkably similar in size, outline, and surface markings; likewise the basidial and tramal characters are not at all distinctive. Slightly more variation is found in the form and location of the cystidia, but even these organs do not display the differences one would expect in a genus composed of so large a number of species. Yet similar as they are, the small differences that do exist in the cystidia and spores furnish the best microscopic characters for purposes of classification in the group.

At this time, the writer is of the opinion that the problems raised by the dubious and ambiguous species of the genus will find satisfactory solution only after many collections have been made, and the fresh plants carefully described, illustrated by good photographs, accurately tinted in exact colors or drawn and painted in water-color or oil, and the specimens properly dried and preserved. As preserved in many of the herbaria, dried specimens have little or no value for comparison of most of the macroscopic characters. With this condition in mind, collecting trips were begun during the summer of 1928 and have been pursued in many parts of the states of Pennsylvania, Maryland, Virginia, and the District of Columbia. In 1929 the mountains or timbered areas of North Carolina, South Carolina, Tennessee, Alabama, Georgia, and Florida were visited. During the very dry year of 1930 attempts to collect specimens were but poorly rewarded, though excursions were extended into the state of New York and the province of Ontario.

These efforts were supplemented as opportunity arose by extended visits to several large herbaria in the eastern United States. The collections of Peck at Albany, New York; of Murrill and others at The New York Botanical Garden; of Atkinson at Cornell University; of Kauffman at the University of Michigan; of E. T. Harper at the Chicago Field Museum, and of Overholts at The Pennsylvania State College were all systematically examined.

In this study every effort has been made to follow the International Code in the matter of nomenclature and synonymy. The temptation to ignore the old inadequate descriptions and to give a new diagnosis and name has been avoided by the writer, at times with great difficulty. New species have been proposed only after it seemed impossible to include the plant under study in a previously established species. Correctness in all cases at this time is impossible. Lange (10), who has extensively collected these plants in northern Europe, and beautifully and exactly reproduced his findings in colors, says, "unfortunately even from the time of Fries there exist some names and diagnoses of species which Fries himself only knew from dried specimens (or even figures) and which are rather problematical and almost impossible to identify."

PHYLOGENETIC CONSIDERATIONS

The writer has found it difficult to satisfactorily place the thirty-nine species here recognized in the Friesian sections mentioned on a preceding page. Based upon macroscopic characters alone, such as were employed by Fries, most of the species herein considered might be logically distributed in his five sections, but when the microscopic characters are introduced the grouping becomes more difficult and less logical. It is the belief of the writer that the phylogenetic relationships in this genus will not be fully understood until a careful study and comparisons are made in all of the related genera within the purple-brown-spored section. The creation of some new terms or the modification of the terms of one of the color standards to adequately express spore color shades as viewed under the microscope would greatly facilitate such a study.

Spore shape, size, and color as well as cystidial shape, location and distribution on the gills must be given proper evaluation in connection with the macroscopic characters before anything but a tentative grouping based on relationships is attempted. As desirable as such a condition might be, it is not believed possible in the present state of our knowledge of this genus to isolate an individual species as an outstanding type around which to build a group of kindred forms.

The species within the scope of this study have been tentatively arranged in the Friesian sections based largely upon their macroscopic characters (FIG. 1, A) and the location of the cystidia (FIG. 1, B).

In the group Fasciculares, which includes the non-hygrophanous, smooth, dry, tough, bright colored forms, have been placed *H. cutifractum*, *H. campanulatum* with cystidia absent; *H. capnoides*, *H. sublateralitium* with cystidia only on sides of gills; *H. fasciculare*, *H. delineatum* and *H. radicosum* with cystidia on both sides and edge of gills.

In the group Velutini, containing those silky pileate species with innate fibrils or streaks, has been placed the single species *H. aggregatum* with cystidia on both sides and edge of gills.

In Flocculosi, which includes the floccose species with superficial, separating scales, have been placed *H. vinosum* with cystidia

H. fragile with cystidia absent has been placed in Fasciculares and Flocculosi; *H. simile* with cystidia on sides of gills only has been placed in Fasciculares and Viscidi; *H. Boughtonii* with cystidia on sides of gills only and *H. rugocephalum* with cystidia on both sides and edge of gills have been placed in Fasciculares and Velutini; *H. elongatipes* with cystidia on edge of gills only has been placed in Viscidi and Appendiculati; *H. Peckianum* with cystidia on edge of gills only has been placed in Viscidi and Velutini; *H. irregulare* with cystidia on sides of gills only has been placed in Velutini and Appendiculati; *H. oblongisporum* with cystidia on both sides and edge of gills has been placed in Flocculosi and Appendiculati; *H. hololanigerum* and *H. echiniceps* with cystidia on both sides and edge of gills have been placed in Flocculosi and Appendiculati; *H. rugoproximum* with cystidia on edge of gills only has been placed in Flocculosi and Fasciculares; *H. maculatum* with cystidia on both sides and edge of gills has been placed in Flocculosi and Velutini; *H. tsugicolum* with cystidia on edge of gills only has been placed in Appendiculati and Viscidi; *H. longipes* with cystidia absent, *H. coronatum* and *H. incertum* with cystidia on edge of gills only have been placed in Appendiculati and Flocculosi; *H. catarium* with cystidia on sides of gills only has been placed in Appendiculati and Velutini; *H. madeodiscum*, *H. hydrophilum* and *H. velutinum* with cystidia on both sides and edge of gills have been placed in Appendiculati and Velutini; *H. caniceps* with cystidia on sides of gills only has been placed in Appendiculati, Flocculosi and Velutini; *H. appendiculatum* with cystidia on both sides and edge of gills has been placed in Appendiculati, Flocculosi, and Velutini.

Thus it may be observed that into the five Friesian sections in full or in part may be placed the species here studied as follows:

	Displaying characters of but one group	Displaying characters of two or more groups	
Fasciculares.....	7 species	4 species	
Viscidi.....	0	2	
Velutini.....	1	1	
Flocculosi.....	3	5	
Appendiculati.....	6	10	
Total.....	17	22	39

It should be noted also that there are reasons other than those mentioned above why a grouping such as is here made should be regarded as having only tentative value. As an example the three species *H. rugocephalum*, *H. Boughtonii* and *H. velutinum*, considered from the standpoint of size, shape, and color of spores, which are almost identical in all three species, would be regarded as having closer relationships to each other than shown in the above scheme. Likewise an aberrant form like *H. irregulare* would be differently placed were the nature of its spores given the weight which they deserve. On the other hand three species such as *H. Candolleianum*, *H. appendiculatum* and *H. incertum* displaying exceedingly close relationships when macroscopic characters alone are considered are more widely separated by their microscopic characters.

ACKNOWLEDGMENTS

Acknowledgment and thanks are due first to Dr. L. O. Overholts, under whose direction this work was begun, for aid, criticism, and advice in the prosecution of this study and for free access at all times to his valuable personal herbarium, notes, and library. To the officers and botanical staff of The Pennsylvania State College the writer expresses his appreciation for assistance rendered at different times and in many ways; to Dr. H. D. House for the privilege of studying the type specimens and the personal notes accumulated by Dr. Chas. H. Peck, and the many other collections in the New York State Museum at Albany; to Dr. Fred J. Seaver for access to all of the collections of the genus at The New York Botanical Garden, and to the Librarian and her staff of the same institution, for much patience and assistance rendered on several occasions; to Dr. E. B. Mains, University of Michigan, for the opportunity of studying the valuable collections of Dr. C. H. Kauffman; to Mr. P. C. Standley of the Chicago Field Museum of Natural History for the privilege of examining the herbarium of Dr. E. T. Harper; to Dr. H. M. Fitzpatrick, Cornell University, for access to the collections and personal notes of Dr. George F. Atkinson, and for the privilege of publishing his heretofore unpublished descriptions of new species; to Mr. John A. Stevenson, Senior Mycologist in charge of Mycological Col-

lections, Bureau of Plant Industry, Washington, D. C., for the privilege of examining that collection, and for many favors which greatly aided the writer in this study.

TAXONOMY OF THE GENUS HYPHOLOMA

HYPHOLOMA Fries, Syst. Myc. 1: 287. 1821.

Pileus thick or very thin, compact, firm, fragile, or soft, viscid, dry, or hygrophanous, glabrous, atomate, floccose, fibrillose, or scaly, whitish, yellowish, reddish, or blackish; margin of pileus inturned at first and adorned with remnants of the usually whitish, flocculose-fibrillose veil; gills adnate, sinuate, or adnexed, infrequently with slight decurrent teeth extending in lines down the stem, concolorous or varying more than the pileus in color; stem central, confluent and homogeneous with the pileus, glabrous, fibrous, or scaly, whitish, yellowish, or brownish; spores smooth, or rough, elliptic, sub-globose, rarely triangular, pip-shaped, or lemon-shaped, at times displaying a hyaline epispore, purple-brown to almost black; cystidia present or absent; odor usually fungoid; taste bitter or pleasant; putrescent; caespitose, gregarious, or rarely solitary; xylophilous.

Type species: *Hypholoma lacrymabundum* Bull. ex Fries, emend. Quélet.

The word *Hypholoma* is from the Greek ($\upsilon\phi\acute{\eta}$, web; $\lambda\acute{\omega}\mu\alpha$, a fringe), having reference to the fragments of the fugacious veil-remnants left pendent on the edge of the pileus. The method of the veil breaking from the stem is the distinguishing character of the genus. It is best observed in young plants. In some species the veil-remnants may not be present in mature specimens. The substance of the pileus is also continuous with that of the stem. The genus contains plants quite variable in character though in most cases the differences are slight and the intergrading frequent. In structure the plants of this genus are analogous to those of the genus *Flammula* of the ochre-spored agarics.

KEY TO THE SPECIES

1. Pileus viscid or sub-viscid, glabrous or atomate.....2.
- Pileus hygrophanous, glabrescent, atomate, or displaying fine
 flocculent particles or scales.....6.
- Pileus dry, never hygrophanous nor viscid, but at times glabrous or
 atomate.....34.
2. Plants growing on lawns or in fields, rarely in woods; pileus white or
 yellowish; spores $6.5-8 \times 3-4.5 \mu$7. *H. incertum*.

- Plants growing in woods, swamps, thickets, or along woodland trails,
rarely on lawns 3.
3. Plants caespitose 4.
- Plants solitary, gregarious, or scattered 5.
4. Cystidia only on sides of gills; pileus with lavender tinge, buff, or
buckthorn-brown; spores $9-12.5 \times 5-7 \mu$ 27. *H. elongatipes*.
- Cystidia only on edge of gills; pileus buckthorn-brown to antimony-
yellow; spores $6-7 \times 4-4.5 \mu$; western plant. 36. *H. tsugicolum*.
- Cystidia absent; pileus buckthorn-brown to antimony-yellow; spores
 $6-7 \times 4-4.5 \mu$ 36. *H. tsugicolum*.
5. Cystidia only on sides of gills; pileus with lavender tinge, buff, or
buckthorn-brown; spores $9-12.5 \times 5-7 \mu$ 27. *H. elongatipes*.
- Cystidia only on sides of gills; pileus cream, gray, ochraceous, or
cinnamon-buff 25. *H. simile*.
- Cystidia only on edge of gills; pileus bay-brown; spores $10-12$
 $\times 5-6 \mu$ 26. *H. Peckianum*.
6. Plants growing in woods, swamps, thickets, or along woodland
trails, rarely on lawns 7.
- Plants growing on lawns, or in fields, rarely in woods; pileus white or
yellowish; spores $6.5-8 \times 3-4.5 \mu$ 7. *H. incertum*.
7. Plants solitary, gregarious, or scattered 15.
- Plants caespitose 8.
8. Cystidia only on sides of gills; pileus cinnamon-drab; spores $8-9.5$
 $\times 3.5-4.5 \mu$ 38. *H. canocephs*.
- Cystidia only on edge of gills 9.
- Cystidia on both sides and edge of gills 11.
9. Pileus with separable pellicle, buckthorn-brown to antimony-yellow;
spores $6-7 \times 4-4.5 \mu$ 36. *H. tsugicolum*.
- Pileus without separable pellicle 10.
10. Pileus date-brown, becoming white; spores $8-9 \times 4-5 \mu$
6. *H. Candolleianum*.
- Pileus with lavender tinge, buff, or buckthorn-brown; spores
 $9-12.5 \times 5-7 \mu$ 27. *H. elongatipes*.
11. Stem rooting in the substratum; pileus honey-ochraceous or tan;
spores $6.5-7 \times 4-5 \mu$ 21. *H. radicosum*.
- Stem not at all rooting in habit 12.
12. Spores smooth, not over 7μ long; stem striate 13.
- Spores smooth, more than 7μ long; stem not striate 14.
- Spores tuberculate, $8-13 \times 7-8 \mu$; pileus cinnamon-buff or clay-color
31. *H. velutinum*.
13. Pileus whitish to pale brownish-ochraceous; spores $5-7.5 \times 3-4 \mu$
16. *H. lacrymabundum*.
- Pileus clove-brown to bone-brown; spores $3.5-5 \times 3.5 \mu$
37. *H. maculatum*.
- Pileus pallid, purplish-gray or clay-color; spores $5-7 \times 3.5 \mu$
8. *H. oblongisporum*.
- Pileus cinnamon or chestnut-brown; spores $4-6 (-7) \times 2.5-4.5 \mu$
10. *H. hydrophilum*.
14. Pileus grayish-white; spores $6.8-8 \times 3.4-5 \mu$ 15. *H. aggregatum*.

- Pileus ochraceous-brown; spores $7-9 \times 3.5-5 \mu$17. *H. echiniceps*.
 Pileus date-brown; spores $5-8 \times 3.5-5 \mu$12. *H. appendiculatum*.
 Pileus rich brown; spores $6-7 \times 3-4 \mu$; western plant...39. *H. californicum*.
15. Cystidia present.....16.
 Cystidia absent.....31.
16. Cystidia only on sides of gills.....17.
 Cystidia only on edge of gills.....19.
 Cystidia on both sides and edge of gills.....22.
17. Spores more than 6μ long.....18.
 Spores 6μ or less long; pileus light ochraceous-buff; spores $5-6 \times 3-3.5 \mu$2. *H. catarium*.
18. Pileus cinnamon-drab; spores $8-9.5 \times 3.5-4.5 \mu$; Oregon plant
 38. *H. caniceps*.
 Pileus grayish-buff with umber-brown scales; spores $6-7 \times 4-5 \mu$,
 very irregular in shape.....3. *H. irregulare*.
 Pileus burnt-umber; spores $7.6-10.2 \times 5-6 \mu$34. *H. atrifolium*.
 Pileus cream-gray, ochraceous or cinnamon-buff; spores $8.5-10.2 \times 5-5.3 \mu$25. *H. simile*.
19. Stem striate above.....20.
 Stem not striate above.....21.
20. Pileus watery-brown, becoming white; spores $6-8 \times 3-4.5 \mu$
 4. *H. cinereum*.
 Pileus umber-brown or alutaceous; spores $6-7 \times 4 \mu$5. *H. coronatum*.
 Pileus white or yellowish; spores $6.5-8 \times 3-4.5 \mu$7. *H. incertum*.
21. Pileus cream-buff; spores $7-8 \times 4-4.5 \mu$; western plant
 35. *H. inocybeforme*.
 Pileus date-brown, becoming white; spores $8-9 \times 4-5 \mu$
 6. *H. Candolleianum*.
 Pileus cream-buff or pale yellow; spores $6-10 \times 3-5.5 \mu$
 14. *H. rugoproximum*.
22. Stem more than 7 cm. long.....23.
 Stem less than 7 cm. long.....30.
23. Spores rough-walled.....24.
 Spores smooth-walled.....25.
24. Pileus cinnamon-buff or clay-color; spores $8-13 \times 7-8 \mu$
 31. *H. velutinum*.
 Pileus tawny to reddish-brown; spores $8-11 \times 5-6 \mu$28. *H. rigidipes*.
25. Spores 8μ or less long.....26.
 Spores more than 8μ long.....29.
26. Plants of western states.....27.
 Plants of eastern states.....28.
27. Pileus clove-brown to bone-brown; spores $3.5-5 \times 3.5 \mu$
 37. *H. maculatum*.
 Pileus rich brown; spores $6-7 \times 3-4 \mu$39. *H. californicum*.
28. Pileus honey, ochraceous, or tan; spores $6.5-7 \times 4-5 \mu$21. *H. radicosum*.
 Pileus date-brown; spores $5-8 \times 3.5-5 \mu$12. *H. appendiculatum*.
29. Stem striate; pileus whitish with lavender tinge, buff, or buckthorn-brown; spores $9-12.5 \times 5-7 \mu$27. *H. elongatipes*.

- Stem not striate; pileus tawny to reddish-brown; spores 8-11
 $\times 5-6 \mu$28. *H. rigidipes*.
30. Pileus liver-brown to chestnut-brown; spores 6.5-8.5 $\times 4-6 \mu$
 11. *H. madeodiscum*.
 Pileus ochraceous to pinkish-buff; spores 7-9 $\times 3.5-4.5 \mu$
 9. *H. hololanigerum*.
 Pileus tawny-brown or reddish-brown; spores 8-9 $\times 5-6 \mu$
 20. *H. delineatum*.
31. Spores more than 7 μ long; stem striate.....32.
 Spores 7 μ or less long; stem not striate.....33.
32. Pileus chestnut-brown, becoming nearly white; spores 6.5-9 $\times 4-5 \mu$
 1. *H. hymenoccephalum*.
 Pileus yellowish-brown; spores 10-12.5 $\times 6-8 \mu$33. *H. longipes*.
33. Pileus umber, tinged with purple; spores 5-6 $\times 2.5-3 \mu$. 13. *H. vinosum*.
 Pileus yellowish, grayish, or sub-ochraceous; spores 6-7 $\times 4-5 \mu$
 18. *H. fragile*.
34. Plants caespitose.....35.
 Plants solitary, gregarious, or scattered.....42.
35. Cystidia only on sides of gills.....36.
 Cystidia only on edge of gills; pileus whitish, with lavender tinge,
 buff, or buckthorn-brown; spores 9-12.5 $\times 5-7 \mu$. 27. *H. elongatipes*.
 Cystidia on both sides and edge of gills.....37.
 Cystidia absent.....41.
36. Pileus yellow with reddish disk; spores smooth-walled, 7-9 $\times 4-5 \mu$
 24. *H. capnoides*.
 Pileus reddish-brown or brownish-gray; spores rough-walled, 8-10
 $\times 5-7 \mu$29. *H. Boughtonii*.
37. Plants rooting in the substratum; pileus honey, ochraceous, or tan;
 spores 6.5-7 $\times 4-5 \mu$21. *H. radicosum*.
 Plants not rooting in the substratum.....28.
38. Gills white or whitish in young plants.....39.
 Gills showing some color in the young plants.....40.
39. Pileus dark brick-red.....22. *H. sublateralitium*.
 Pileus grayish-white.....15. *H. aggregatum*.
40. Gills yellow in young plants; pileus lemon to sulphur-yellow, reddish
 on disk; spores 6-7 $\times 4-5 \mu$23. *H. fasciculare*.
 Gills purple-brown in young plants; pileus ochraceous-brown; spores
 7-9 $\times 3.5-5 \mu$17. *H. echiniceps*.
41. Pileus ochraceous; spores 9-11 $\times 6-8 \mu$; western plant
 32. *H. campanulatum*.
 Pileus cream, later grayish-buff; spores 7.5-9.5 $\times 4-5 \mu$
 19. *H. cutifractum*.
42. Cystidia only on sides of gills.....43.
 Cystidia only on edge of gills.....44.
 Cystidia on both sides and edge of gills.....45.
 Cystidia absent.....48.
43. Pileus cream, gray, or ochraceous-buff; spores smooth-walled,
 8.5-10 $\times 5-5.3 \mu$25. *H. simile*.
 Pileus reddish-brown or brownish-gray; spores rough-walled,
 8-10 $\times 5-7 \mu$29. *H. Boughtonii*.

44. Pileus whitish with lavender tinge, buff, or buckthorn-brown;
spores $9-12.5 \times 5-7 \mu$ 27. *H. elongatipes*.
Pileus cream-buff or pale yellow; spores $6-10 \times 3-5.5 \mu$
14. *H. rugoproximum*.
45. Spores rough-walled 46.
Spores smooth-walled 47.
46. Pileus cream-buff or clay-color; spores $8-13 \times 7-8 \mu$... 31. *H. velutinum*.
Pileus tawny to reddish-brown; spores $8-11 \times 5-6 \mu$... 28. *H. rigidipes*.
Pileus watery-brown to tawny, alutaceous, tan, or orange-cinnamon;
spores $9-12 \times 5-9 \mu$ 30. *H. rugocephalum*.
47. Pileus cream-brown to bone-brown; spores $3.5-5 \times 3.5 \mu$
37. *H. maculatum*.
Pileus tawny to reddish-brown; spores $8-11 \times 5-6 \mu$... 28. *H. rigidipes*.
48. Pileus umber, tinged with purple; spores $5-6 \times 2.5-3 \mu$... 13. *H. vinosum*.
Pileus yellowish, grayish or sub-ochraceous; spores $6-7 \times 4-5 \mu$
18. *H. fragile*.

1. *HYPHOLOMA HYMENOCEPHALUM* Peck, Ann. Rep. N. Y. State
Mus. 31: 34. 1879.

(PLATE 27, FIG. 14)

Pileus 2.5-5 cm. broad, campanulate or convex, then plane, or at times umbonate, hygrophanous, chestnut-brown when young and moist, pallid or nearly white when dry, rugulose, sub-atomate, margin striate, especially when moist; context very thin, white; gills adnate, thin, narrow, close, pallid or dingy-white, then purplish-brown, drying almost black; stem 5-10 cm. long, 2-3 mm. thick, slender, easily splitting longitudinally, stuffed or hollow, striate and atomate above, white; veil delicate, evanescent, white; spores $6.5-9 \times 4-5 \mu$, smooth, elliptic-ellipsoid to considerably elongate; cystidia none.

HABITAT: Under shrubs and small trees among fallen leaves on damp ground.

HABIT: Solitary or gregarious.

TYPE LOCALITY: Adirondack Mountains, New York.

DISTRIBUTION: Known only from the type and a single collection from the state of Maryland.

This fragile little plant is exceedingly close to *H. appendiculatum* Bull. ex Fries, *H. Candolleianum* Fries and *H. incertum* Peck. In size and general appearance it is closest to *H. appendiculatum* and *H. incertum*, but it is thinner and more fragile than either and without cystidia. It bears spores more like those of *H. Candolleianum*, and is a rarer plant than any one of the three.

2. *HYPHOLOMA CATARIUM* Fries, Hym. Eur. 296. 1874.

(PLATE 26, FIG. 2; PLATE 29, FIG. 31)

Pileus 1.2–2.5 cm. broad, conic in very young plants, hemispheric, then expanded, hygrophanous, drying from margin to center, light ochraceous-buff to light buff, smooth except for a few scattered, longitudinal, innate fibers near the edge, none over center, margin even, appendiculate with very fine fragments of white veil which soon turn brown; context 2 mm. thick over stem, scarcely any at margin, firm, white or concolorous, odor and taste not distinctive; gills 3–4 mm. broad, adnate, close to crowded, white, light-drab and finally fuscous; stem 2.5–4 cm. long, 2–4 mm. thick, hollow, faintly striate and pruinose above, glabrous and shining below, base incrassated and white floccose, pallid or white; veil very fine, white; spores $5-6 \times 3-3.5 \mu$, smooth, ellipsoid-oblong, purple-brown under the microscope; basidia 4-spored, $6-7 \times 12-13 \mu$; cystidia on sides of gills only, projecting 13–14 μ , hyaline, vesiculose, ventricose, or sub-cylindric.

HABITAT: In moss along mountain trail.

HABIT: Gregarious, sub-caespitose or solitary.

TYPE LOCALITY: Italy.

DISTRIBUTION: Known in North America from a single collection from Pennsylvania.

ILLUSTRATION: Cooke, Ill. Brit. Fungi *pl.* 1176. [1180]

This little European plant appeared in the fall at the time when *H. hydrophilum* Bull. ex Fries was most common, and though the two have very similar microscopic characters, *H. catarium* is easily recognized by its shape, color, habitat, and habit of growth. My collection displayed definitely a solitary habit of growth. Rea says this species is rare in Europe.

3. *Hypholoma irregulare* sp. nov.

Hypholoma populinum Britz. var., Kauffman, Agar. Mich. 1: 261. 1918.

(PLATE 26, FIG. 3; PLATE 27, FIG. 15)

Pileus 1–2.5 cm. broad, convex, to sub-campanulate, obtuse, finally expanded, hygrophanous, grayish-buff, scales umber-brown to purplish-brown, fading to pale grayish-white, innately pilose-scaly, not striate, margin appendiculate at first from the veil; context thin, concolorous, odor none; gills adnate-seceding, rounded behind, moderately broad, close, thin, at first whitish, soon drab, then dark purplish-brown, edge white, fimbriate; stem

2-4 cm. long, 1.5-2 mm. thick, equal, white, dotted with fuscous, fibrillose scales, stuffed, then hollow, shining when dry, base sub-mycelioid; veil membranous, evanescent, white; spores $6-7 \times 4-5 \mu$, variously shaped, sub-triangular, inequilateral-elliptic, sub-angulate, sometimes curved or the shape of corn-kernels, dark purple-brown; cystidia only on sides of gills, $40-50 \times 15-18 \mu$, scattered, clavate to obclavate or sub-ventricose, stalked.

HABITAT: On very rotten wood in frondose woods or swamps.

HABITAT: Solitary.

TYPE LOCALITY: Bay View, Michigan (University of Michigan Herb., Bay View Collection, Sept. 19, 1906).

DISTRIBUTION: Illinois, Michigan.

This species is distinctly different in size, color, spore size, and cystidial characters from any of the European species in which angular and irregular shaped spores have been observed. Kauffman in his note expressed the belief that this was probably a distinct species and my examination of his plants led to the same conclusion. The collection upon which this species is based and three other collections made by Kauffman have been examined.

Hypholoma irregulare. Pileo 1-2.5 cm. crassus, e convexo subcampanulato, obtuso tunc expanso, hygraphano, cinereo-luteo, umbrobrunneo vel purpureo-brunneo vel sordide albo, furfore adpresso, ne striato; lamellis adnatis secedentibus, confertis primo pallide ochraceo dein purpureo-brunneo; stipite 2-4 cm. longus, 1.5-2 mm. crassus, aequali, albo, fibrillis furfore; sporis $6-7 \times 4-5 \mu$ ovato-ellipsoideis, subtriangulis, ellipsoideis, frumento-grano; cystidia laterae lamellae.

4. *Hypholoma cinereum* sp. nov.

(PLATE 27, FIG. 16; PLATE 30, FIG. 34)

Pileus 1-3 cm. broad, oval, hemispheric, obtuse, then campanulate to plane, hygrophanous, fragile, pale water-brown and even when moist, pallid-ochraceous or nearly white when dry, assuming a livid-gray or water-soaked appearance when re-moistened, at times sprinkled with flecks or flocculent scales, atomate or glabrescent; context thin, soft, white, odor and taste pleasant; gills 1.5-2.5 mm. broad, adnate-seceding, close, linear sub-ventricose, white at first, becoming pinkish then fuscous-purplish, edge white fimbriate; stem 3-6 cm. long, 3-7 mm. thick, nearly equal, undulate, silky-fibrillose, pruinose-floccose at apex, white, hollow or at times stuffed, even or slightly enlarged at base and matted in mycelium; veil delicate, evanescent, white; spores $6-8 \times 3-4.5$

μ , smooth, oblong-elliptic, elliptic, or nearly cylindric, pale brown under the microscope; cystidia $40-50 \times 10-15 \mu$, abundant on edge of gills, conspicuous, flask-shaped.

HABITAT: On wood at base of trees, and in humus in deciduous forests.

HABIT: Gregarious or scattered.

TYPE LOCALITY: Anne Arundel Co., Md. South River woods. (Parker Herb. 1579; Overholts Herb. 14236.)

DISTRIBUTION: New York, Pennsylvania, Maryland, District of Columbia, South Carolina, Michigan, and Illinois.

This species is identical with the plant which Kauffman called *H. saccharinophilum* Peck in spore shape and size and in the location, shape and size of the cystidia.

Kauffman observed, and I have since verified several times, that a peculiar color change takes place in mature plants of this species when they become wet. The pileus is grayish-white when dry, but during wet weather or when it is moistened artificially, the plant immediately assumes a livid-gray appearance. In this color-change character, in the absence of striations on the margin, and its small size, this species is distinctive and easily recognized.

Hypholoma cinereum. Pileo 1-3 cm. crassus, convexo, obtuso, tunc campanulato expanso, hygrophano, tenue, ex aqua-fusco cum humido, pallida-ochra, prope alba cum arido, floccoso-furfore, atamato, glabro; lamellis 1.5-2.5 mm. crassus, adnatis secedentibus, confertis, ex albo purpureo-fusco; stipite 3-6 cm. longus, 3-7 mm. crassus, subaequali, e fibrilloso floccoso supra basi tumido; sporis $6-8 \times 3-4.5 \mu$ ellipticis-oblongis, cylindraceo; cystidia $40-50 \times 10-15 \mu$ orae lamellae.

5. *HYPHOLOMA CORONATUM* Fries, Hym. Eur. 295. 1874.

(PLATE 27, FIG. 17)

Pileus 4-7 cm. broad, oval, later convex-campanulate, obtuse or sub-umbonate, hygrophanous, umber-brown on disk, paler toward the margin, whitish-tan or pale alutaceous when dry, disk frequently retaining an umber shade and at length blackish stained in spots, at first dotted with white, flocculent, superficial scales, soon denuded, even or obscurely wrinkled on margin; margin hung by the remnant of a veil in a dentiform manner; context thin, concolorous, odor and taste pleasant; gills narrowly adnate, seceding, very narrow, crowded, at first dingy white, soon pale lilaceous-brown, then umber, edge minutely white fimbriate; stem 5-7 cm. long, 3-4 mm. thick, tapering or sub-equal, hollow,

slightly toughish, white, dingy in age, often minutely flocculose-scaly, then glabrescent and shining, even, sometimes sub-compressed; spores $6-7 \times 4 \mu$, smooth, elliptic, purplish-brown; cystidia none on sides, on edge of gills broadly cylindric, obtuse, abruptly short-stipitate, $36 \times 10 \mu$.

HABITAT: Growing on leaf-mold, fallen leaves, and very rotten wood.

HABIT: Gregarious or scattered.

TYPE LOCALITY: Sweden.

DISTRIBUTION: New York and Michigan.

ILLUSTRATION: Fries, Ic. Hym. *pl.* 134.

This description is based on that of Kauffman, who regards this European plant as very close to *H. incertum* Peck in shape and size, differing from it in the umber color of the entire very young pileus, which has evanescent, white-floccose scales sprinkled over it; in the less roseate hue of the gills in the intermediate stage, and lacking the violet-tinged margin of the pileus in age.

6. *HYPHOLOMA CANDOLLEANUM* Fries, Epicr. Syst. Myc. 224. 1838.

(PLATE 26, FIG. 12; PLATE 27, FIG. 18; PLATE 28, FIG. 29)

Pileus 5-10 cm. broad, convex, sub-campanulate, finally expanded, hygrophanous, bay or date-brown when young and moist, becoming white with yellow or ochraceous center when dry, smooth or faintly striate on the margin, frequently splitting longitudinally and with the margin upturned; context sub-membranous, thin, white; gills adnexed, and broadly sinuate behind, close, narrow, violet-tinted in young plants, later cinnamon-brown or purplish-brown; stem 5-7 cm. long, 3-7 mm. thick, glabrous or at times fibrillose, hollow, striate above, easily splitting longitudinally, white; veil adorns young plants as a thin, white, woven membrane; spores $8-9 \times 4-5 \mu$, smooth, elliptic; cystidia on edge of gills, subcylindric, sub-ventricose, projecting $20-35 \mu$, $9-11 \mu$ in width.

HABITAT: On ground about very rotten logs or stumps.

HABIT: Caespitose or scattered.

TYPE LOCALITY: Sweden.

DISTRIBUTION: New York, Pennsylvania, Maryland, District of Columbia, Illinois, and Washington.

ILLUSTRATIONS: Britzelmayer, Hym. *pl.* 309, *fig.* 111; Cooke, Ill. Brit. Fungi *pl.* 546 [586]; Corda, Ic. *pl.* 63, *fig.* 8; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 83B.

See *H. appendiculatum* Bull. ex Fries for data as to the differences between this species and *H. incertum* Peck.

7. *HYPHOLOMA INCERTUM* Peck, Mem. N. Y. State Mus. 4: 165. 1900.

Agaricus (Hypholoma) incertus Peck, Ann. Rep. N. Y. State Mus. 29: 40. 1878.

(PLATE 26, FIG. 9; PLATE 27, FIG. 19; PLATE 30, FIG. 33)

Pileus 2–6 cm. broad, ovate, or sub-campanulate, then expanded, at length splitting radially, hygrophorous, pale honey-yellow, then buff to white, becoming white when dry, with frequently a slightly darker or pale yellow center, margin at times displaying faint tints of lilac or violet, white flocculent, eventually glabrous, even or but slightly wrinkled when dry, wavy, with white remnants of the veil, especially in young plants; context thin, white, odor and taste pleasant; gills adnate, close, narrow, white, dingy lilac, or rosy-brown, finally purplish or darker, edge white fimbriate; stem 2.5–8 cm. long, 2–6 mm. thick, slender, equal, hollow, easily splitting lengthwise, even, white, innately silky, flocculose above; spores 6.5–8 (–9) \times 3–4.5 μ , smooth, ellipsoid or oblong-ellipsoid; cystidia only on edge of gills, hyaline, sac-shaped or flask-shaped, obtuse, conspicuous, projecting 20–40 μ , 7–12 μ in width.

HABITAT: In grass on lawns, in pastures, at base of stumps, or along grassy roadsides.

HABIT: Gregarious, sub-caespitose, or at times scattered.

TYPE LOCALITY: Port Jefferson, New York.

DISTRIBUTION: Massachusetts, New York, Pennsylvania, Maryland, District of Columbia, Louisiana, Colorado, and California.

ILLUSTRATIONS: Hard, Mushr. *fig.* 262; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 83, *Fig.* c; Marshall, Mushr. Book *pl.* 80; Peck, Ann. Rep. N. Y. State Mus. 52: *pl.* 58, *fig.* 13–20; Peck, Mem. N. Y. State Mus. *pl.* 60, *fig.* 1–9.

This species grades into *H. appendiculatum* Bull. ex Fries on the one hand, and into *H. Candolleianum* Fries on the other and cannot be sharply distinguished from either. I am of the opinion that this is a variable species, which should include all three forms,

but it will be necessary to examine many more fresh specimens before such a statement can be made positively. From *H. Candolleanum* it seems to differ in its lighter colored pileus and adnate gills which are white at first, in the stem which is not or seldom striate, and in having cystidia only on the edge of the gills. From *H. appendiculatum* it differs slightly in habit of growth, paler pileus, and size of spores. Peck regarded it as intermediate between the two. In the eastern part of the United States, at least, it is probably more frequently collected than either of the other two. See *H. appendiculatum* Bull. ex Fries for additional notes on this species.

8. *Hypholoma oblongisporum* sp. nov.

(PLATE 26, FIG. 4; PLATE 27, FIG. 20; PLATE 29, FIG. 30)

Pileus 1–1.8 cm. broad, conic, slightly umbonate, faintly striate when moist, floccose, fibrillose, with filiform, brown strands of hyphae superficial or aggregated in very small patches, cottony on the margin giving the outline an irregular appearance, hygrophanous, pallid-purplish-gray to clay-color except on center which is honey-yellow in drying, then sepia or dark brown, the marginal portions almost black when dry; context exceedingly thin, white, odor fungoid, taste tardily bitter; gills adnate, 1–2 mm. broad, narrowed toward the margin with short ones liberally interspersed, crowded, white, grayish and finally purplish or grayish-brown; stem 1.5–3.5 cm. long, 2–3 mm. thick, hollow, equal, flocculose, white, the upper quarter striate, drying pallid or white; spores $5-7 \times 3.5 \mu$, smooth, oblong or ellipsoid, purplish-brown in mass and intermediate between the spore colors of *H. sublateralitium* and *H. hydrophilum*; basidia $13-15 \times 6-7 \mu$; cystidia exceedingly numerous and conspicuous on both sides and edge of gills, bottle-shaped, sub-fusoid, or pyriform, subulate and sub-capitate at the apex.

HABITAT: On clay bank in road cut.

HABIT: Caespitose in dense clusters.

TYPE LOCALITY: Near Stone Creek, Huntingdon Co., Pennsylvania. (Parker Herb. 3876; Overholts Herb. 14058.)

DISTRIBUTION: Known only from the type locality.

This plant seems to be intermediate between *H. hydrophilum* Bull. ex Fries and *H. madeodiscum* Peck. It is smaller and differs distinctly in general shape, the nature of the surface, and the color of the pileus. Its spore-print on white paper is lighter

brown than that made by *H. sublateritium* Schaeff. ex Fries. In spore size it most nearly approaches *H. hydrophilum*. Oblong spores are occasionally found in both *H. hydrophilum* and *H. madeodiscum* but they predominate in this species. In the location of the cystidia it most closely resembles *H. madeodiscum*, differing only in the shape which these organs assume.



FIG. 2. *Hypholoma sublateritium* Fries. (Common Bricktop Mushroom.)

Hypholoma oblongisporum. Pileo 1-1.8 c., crassus, conico, umbonato, substrato cum humido, flocculoso, fibrilloso, strato subtili fibrilloso, fusco, margine gossypino-fibrilloso, hygraphano, pallido-purpuris e cinero, argilla, disco luteo siccans, tunc cinero fusco-nigricantibus; lamellis adnatis 1-2 mm. crassus, confertis, albo cinero-fusco vel purpureo; stipite 1.5-3.5 cm. longus, cavo, aequali, floccoso, striato supra, siccans oblongis-ellipsoideis; cystidia utrimque et orae lamellae.

9. *HYPHOLOMA HOLOLANIGERUM* Atkinson, Ann. Myc. 7: 371. 1909.

Drosophila hololanigera (Atk.) Murrill, Mycologia 14: 70. 1922.

(PLATE 27, FIG. 21)

Pileus 2-2.5 cm. broad, ovoid to convex, hygrophanous, at first watery-brown, later pale ochraceous-buff to pinkish-buff on drying, densely covered with delicate, white, fibrous scales, not striate; gills adnate, elliptic, purplish-brown, whitish on edge; stem 6-7 cm. long, 4-5 mm. thick, slender, hollow, fragile, even, white with a very pale pink tint; spores $7-9 \times 3.5-4.5 \mu$, sub-ellipsoid, slightly inequilateral, reddish-purple, smooth; cystidia on sides of gills, $40-50 \times 12-15 \mu$, ellipsoid, stalked, on edge $50-80 \times 12-15 \mu$, very numerous, cylindric, narrowly clavate, sub-ventricose and sub-capitate, straight or flexuous.

HABITAT: On very rotten wood in woods.

HABIT: Solitary.

TYPE LOCALITY: Ithaca, New York.

DISTRIBUTION: Known only from the type locality.

This description is based upon the original and notes by Atkinson. I did not see the type collection.

10. *HYPHOLOMA HYDROPHILUM* Bull. ex Fries, Epicr. Syst. Myc. 225. 1838.

Agaricus hydrophilus Bull. Herb. Fr. pl. 511, fig. a-h. 1791.

Bolbitius hydrophilus Bull. ex Fries, Hym. Eur. 333. 1874.

(PLATE 26, FIG. 10; PLATE 27, FIG. 22; PLATE 28, FIG. 28; PLATE 30, FIG. 36)

Pileus 2-6 cm. broad, conic, campanulate-convex, then expanded, hygrophanous, cinnamon-brown to chestnut-brown or auburn when wet, ochraceous-buff to warm-buff or isabella when dry, darker on the center, margin even or sub-striate, often cracking irregularly, wavy, less frequently covered with gray or white silky hairs; context thin (2 mm. or less thick), white or concolorous, odor and taste not characteristic; gills 2-4 (-6) mm. broad, adnate-seceding, thin, crowded, grayish-brown, purplish-brown, or darker, edge minutely white fimbriate when young; stem 4-7 cm. long, 5-7 mm. thick, equal or slightly enlarged below as it approaches the white myceloid mat at the base, hollow, elastic, easily splitting, glabrous except for the pruinose apex which is at times striate, shining white; spores $4-6 (-7) \times 2.5-4.5 \mu$, smooth, pale purplish-brown under the microscope; cystidia few, scattered on sides of gills, hyaline, sub-cylindric, projecting $20-25 \mu$, $7-12 \mu$ in width, solitary or clustered on edge, bottle-shaped.

HABITAT: In woods, on or near decaying stumps, exposed roots, and in soil rich in woody debris.

HABIT: Caespitose in dense clusters.

TYPE LOCALITY: France.

DISTRIBUTION: New York, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, and Florida.

ILLUSTRATIONS: Bulliard, Champ. Fr. *pl.* 511, *fig.* 2-*h*, beautifully illustrates this plant; Cooke, Ill. Brit. Fungi *pl.* 605-*b* [589]; Ricken, Blätterp. Deutsch. 3: *pl.* 64, *fig.* 6.

This species, found everywhere in the wooded areas of the eastern United States, is said to be very common in Europe. Lange says he has believed it to be *H. appendiculatum* Bull., but "to avoid new confusion," along "with most modern authors," he now designates it as *H. hydrophilum*. In view of its wide distribution Murrill's exclusion of the species from his list and Peck's failure to include it in his monograph of the New York species puzzled me for a time. However, in the light of Lange's statement, it seems highly probable that Peck recognized this plant as *H. appendiculatum*, and he refers in his note to the confusion which has resulted from Bulliard's application of the name *H. appendiculatum* to two plants.

11. *HYPHOLOMA MADEODISCUM* Peck, Ann. Rep. N. Y. State Mus. 38: 88. 1885.

(PLATE 28, FIG. 26)

Pileus 2-6 cm. broad, convex, then expanded, hygrophanous, drying from margin to center, liver-brown to chestnut-brown when moist, drab to isabella dry, smooth or rugose, at times atomate, margin thin, even, silky-fibrillose in young plants and frequently upturned; context thin, pallid or concolor, taste mild, odor not characteristic; gills adnexed, slightly sinuate, 2-2.5 mm. broad, crowded, white or pallid then purplish-brown; stem 4-7 cm. long, 4-8 mm. thick, equal or slightly enlarged at base, glabrous or slightly fibrillose, hollow, at times obscurely striate at apex, white; veil very delicate, evanescent; spores 6.5-8.5 \times 4-6 μ , smooth, oblong, ellipsoid, or oblong-ellipsoid, purplish-brown; cystidia abundant on sides and edge of gills, hyaline, projecting 13.6-20.4 μ , not always conspicuous, bottle-shaped, subcapitate.

HABITAT: On dead wood or in soil very rich in humus.

HABIT: Solitary, gregarious, or less frequently caespitose.

TYPE LOCALITY: Adirondack Mountains, New York.

DISTRIBUTION: New York, Pennsylvania, District of Columbia, Maryland, and Virginia.

ILLUSTRATION: Murrill, *Mycologia* 7: *pl.* 158, *fig.* 7.

This plant is closely related to *H. hydrophilum* Bull. ex Fries with which it has been frequently confused. Its white gills, the drying of the pileus from margin to center, lack of conspicuous cystidia, and general habit of growth should distinguish it, but probably not without some difficulty. I have found the two species growing from the same stump several times and have come to know it best by its scattered habit of growth. Peck had seen it but once and recorded it as rare. I have found it quite common in late summer and early fall.

12. *HYPHOLOMA APPENDICULATUM* Bull. ex Fries, *Epicr. Syst. Myc.* 224. 1838.

Hypholoma flocculentum McClatchie, *Proc. So. Calif. Acad. Sci.* 1: 381. 1897.

(PLATE 26, FIG. 5; PLATE 28, FIG. 27)

Pileus 2-7 cm. broad, ovate, then campanulate-hemispheric or frequently expanded, floccose or fibrillose, finally naked, slightly wrinkled or atomate, splitting radially, hygrophanous, date-brown when young and moist, isabelline to ochraceous when dry, slightly darker on the disk; margin appendiculate from the white veil; context thin, sub-membranous, pallid; odor and taste not distinctive; gills broadly adnate, ascending, crowded, nearly equal, white in young plants, grayish-purple, and finally purplish-brown or fuscous; stem 3-10 cm. long, 3-6 mm. thick, fragile, enlarging slightly downward; glabrous below, pruinose and at times striate at apex; veil floccose-membranous, white, at times forming a temporary ring on the stem; spores $5-8 \times 3.5-5 \mu$, smooth, almost cylindric-elliptic, very light brown under the microscope; cystidia on sides and edge of gills, lanceolate, less frequently cylindric or pyriform, at times constricted in the middle, projecting $22-35 \mu$, $9-13 \mu$ in width.

HABITAT: In deciduous woods on well rotted logs and about decaying stumps.

HABIT: Solitary, gregarious, or caespitose.

TYPE LOCALITY: France.

DISTRIBUTION: New York and Pennsylvania.

ILLUSTRATIONS: Atkinson, *Stud. Am. Fungi* *fig.* 26, 27; Bulliard, *Champ. Fr.* *pl.* 392; Burt. *Ic. Farl.* *pl.* 67; Cooke, *Ill. Brit. Fungi*

pl. 547 [587]; Harper, Trans. Wisc. Acad. Sci. 18: pl. 22, 23; Patterson & Charles, Bull. U. S. Dept. Agr. 175: pl. 27, fig. 2; Ricken, Blätterp. Deutsch. 2: pl. 64, fig. 4; White, Bull. Conn. Geol. Nat. His. Surv. 15: pl. 27.

This plant, *H. Candolleianum* Fries, and *H. incertum* Peck are very closely related species, probably not displaying differences of specific rank, but since the two European plants are generally recognized and kept separate by the old world mycologists, it has seemed best to follow that course until opportunity is had to examine a larger number of collections of fresh specimens. *H. Candolleianum* is the largest of the three and has adnexed instead of adnate gills and larger spores. It and *H. incertum* display cystidia on the edge of the gills, while these organs are found on both the sides and edge of the gills of this species. *H. incertum* is smaller than either of the European forms and differs in the color of the gills, the nature of the cystidia, and the habitat.

The characters in which these three plants differ may be summarized as follows:

H. APPENDICULATUM Bull. ex Fries.

Pileus: 2-7 cm. broad, flocculose or fibrillose, isabelline to ochraceous.

Gills: broadly adnate, white in young plants.

Spores: $5-8 \times 3.5-5 \mu$.

Cystidia: on sides and clustered on edge of gills.

Habitat: in deciduous woods.

H. CANDOLLEANUM Fries.

Pileus: 5-10 cm. broad, glabrous, almost white becoming yellowish, faintly striate.

Gills: adnexed, violet-tinted.

Spores: $8-9 \times 4-5 \mu$.

Cystidia: on edge of gills only.

Habitat: in deciduous woods.

H. INCERTUM Peck.

Pileus: 2-6 cm. broad, flocculent, honey-yellow to buff.

Gills: adnate.

Spores: $6.5-8 \times 4-6 \mu$.

Cystidia: on edge of gills only.

Habitat: in fields and cultivated ground.

Observation of the collection dates on specimens in herbaria and the few collections made by myself suggest that *H. appendiculatum* Bull. ex Fries and *H. incertum* Peck are plants of late spring and summer while *H. Candolleianum* Fries may be found later in the season in the middle Atlantic states.

13. *HYPHOLOMA VINOSUM* Kauffman, Agar. Mich. 1: 261. 1918.

Pileus 0.5–2 cm. broad, convex, campanulate, sub-umbonate, umber colored, obscurely tinged with purple, darker in the center, pulverulent-floccose, velvety in appearance, dry, even, obscurely rugulose, margin appendiculate at first by fragments of the veil; context thin, dingy white, fragile; gills adnate, seceding, crowded, rounded behind, ventricose and rather broad, bright vinaceous-umber, finally dark umber, edge entire; stem 2–4 cm. long, 1–2 mm. thick, equal except for the enlarged base, straight, slender, hollow vinaceous-umber color persisting, pulverulent like the pileus, exuding a slight purplish juice when broken in the fresh conditions; veil thin, evanescent, at times forming a fugacious ring on the stem; spores $5-6 \times 2.5-3 \mu$, smooth, oblong, obtuse at the ends; cystidia none.

HABITAT: On very decayed wood, or on logs in mixed forests of hemlock and beech.

HABIT: Solitary.

TYPE LOCALITY: Bay View, New Richmond, Michigan.

DISTRIBUTION: Known only from the type locality.

The above description is based upon that of Kauffman, who says, "this striking little *Hypholoma* is known by its tinge of dark wine-color mixed with umber, the purplish watery juice of the stem and the minute spores. The trama of the gills and the pileus is composed of large, inflated cells, $60-90 \times 20 \mu$, and the surface layer of the pileus of globose cells, several rows thick, up to 30μ diameter, tinged smoky vinaceous. It has no relationships to such plants as *Lepiota haematosperma* (Fries) Bres. and *Armillaria haematites* Berk. & Br., which are much stouter plants, have whitish or red-tinged spores, and well developed annulus. It approached more closely *Psalliota echinata* Fries, but the gills are not free, and the trama is composed of larger cells. The pileus never has pointed scales, and is differently colored. The base of the stem is slightly bulbous."

14. *Hypholoma rugoproximum* sp. nov.

(PLATE 26, FIG. 1; PLATE 27, FIG. 23; PLATE 30, FIG. 35)

Pileus 3-5 cm. broad, convex-campanulate, nearly expanded, dry, cream-buff, or pale yellow when expanded, radially rugose toward the margin, disk smooth, covered with numerous small whitish scales arranged in concentric rings as remnants of the floccose, universal veil; context two-layered, the lower floccose, the upper a tissue of large sub-globose to sub-pyriform cells about two layers in thickness and more or less angled by mutual pressure, odor and taste not marked; gills adnexed, broad behind, rounded, gradually becoming narrower toward the margin, the trama of parallel, slightly flexuous threads, light purple; stem 8-12 (-13) cm. long, 4-5 mm. thick, fibrous, striate, even, minutely downy above, white, with compact mass of mycelium at the base; veil membranous, evanescent; spores 6-10 \times 3-5.5 μ , smooth, irregularly oval to irregularly oblong, the ends rounded, purple under the microscope; basidia short-clavate, 4-spored; cystidia none on sides of gills, the edge with inconspicuous, clavate cells, but slightly larger than the basidia.

HABITAT: On ground in woods.

HABIT: Gregarious, at times two or three joined at the base.

TYPE LOCALITY: Six mile Creek, Cayuga Lake Basin, New York. (Herbarium Cornell University 15312).

DISTRIBUTION: Known only from the type locality.

This plant was described but not named by Atkinson. Dr. H. M. Fitzpatrick kindly gave the writer permission to publish this heretofore unpublished description and illustration. The plant has close affinities with *H. fragile* Peck, from which it differs in its larger spores, cystidia, and the nature of the tramal tissue in the pileus.

Hypholoma rugoproximum. Pileo 3-5 cm. crassus, convexo-campanulato dein expanso, sicco, subisabellino vel sordide argillaceo vel albo-luteo, margine radiato-plicato, disca levis et ad albus furfore ad concirculem; lamellis adnexus pallido-purpureis; stipes 8-12 (-13) cm. longus 4-5 mm. crassus, fibrilloso, striato, albo; sporis oblongis; cystidia orae lamallae.

15. *HYPHOLOMA AGGREGATUM* Peck, Ann. Rep. N. Y. State Mus. 46: 106. 1893.

Pileus 2-5 cm. broad, convex, or sub-campanulate, dry, grayish white, surface spotted by appressed, brownish fibrils, margin even; context thin, soft, and white, (odorless, taste mild

fide Murrill); gills adnate, crowded to sub-distant, rounded behind, smooth, whitish in young plants becoming brown or blackish-brown, whitish on the edge; stem 5–8 cm. long, 3–6 mm. thick, equal, slender, hollow, slightly floccose, or fibrillose, white; veil apparent only in very young plants, flocculent, white; spores $6.8-8 \times 3.4-5 \mu$, smooth, oblong, elliptic, slightly curved, light brown under the microscope; basidia $10-15 \times 3-6 \mu$; cystidia on sides and edge of gills, not abundant, sac-shaped or flask-shaped, capitate, projecting $10-18 \mu$, $7-8 \mu$ in width.

HABITAT: Rich woods about stumps.

HABIT: Caespitose.

TYPE LOCALITY: Alcove, New York.

DISTRIBUTION: Massachusetts, New York, and New Jersey.

ILLUSTRATION: Murrill, *Mycologia* 6: pl. 113, fig. 5.

This seems to be a rare species. Many collections which I have examined in herbaria determined as *H. aggregatum*. Peck are *H. lacrymabundum*, Bull. ex. Quél. Peck says the caespitose character and pale spotted pileus are distinguishing features of this species. It seems to be related to *H. silvestre* Gill., but that is a larger, stouter plant with differently colored gills in the young plant. From *H. leucolephrum* Berk. & Br., which it resembles in some respects, it differs in the absence of the hygrophanous character of the pileus and in the presence of the fibrillose spots. Harper and Beardslee (7) think this species identical with the European plant *H. Storea* var. *caespitosum*. I have never had opportunity to examine specimens of the latter species.

16. *HYPHOLOMA LACRYMABUNDUM* Bull. ex Fries, emend. Quél.
Champ. Jura et Vosges 113. 1872.

Pileus 3–10 cm. broad, convex, sub-campanulate, obtuse, or discoid, dry whitish to buff, later pale brownish-ochraceous when moist, with finely appressed scales, except on the disk, and there darker and at times rugulose; context thick except at the margin, firm, white, odor and taste not distinctive; gills adnate or broadly sinuate, seceding, narrow, crowded, whitish in young plants, finally purplish-brown, the edge white flocculose, sometimes distilling water from the edges; stem 5–11 cm. long, 5–10 mm. thick, hollow, slender, equal, striate above, fibrillose or sub-scaly, glabrescent below, pallid or whitish, then sordid or yellowish at the base when injured; spores $5-7.5 \times 3-4 \mu$, smooth, elliptic, slightly curved, dark brownish-purple under the microscope;

cystidia on sides and edge of gills, ventricose, hyaline, short, abundant, $30-45 \times 10-15 \mu$.

HABITAT: In rich soil about stumps and decaying logs.

HABIT: Caespitose.

TYPE LOCALITY: Sweden.

DISTRIBUTION: Pennsylvania, Maryland, Michigan, Illinois, and Washington.

ILLUSTRATIONS: Cooke, Ill. Brit. Fungi *pl.* 543 [580] (as *H. Storea* var. *caespitosa*); Fries, Ic. Hym. *pl.* 134, *fig.* 1; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 78; Kauffman, Agar. Mich. 2: *pl.* 52.

No plant in the genus has been subject to a greater amount of confusion. Originally illustrated by Bulliard (*pl.* 194), it was the first specific name mentioned by Fries (4) in establishing the genus. In his discussion of European plants R. Maire (11) explained how Fries erroneously attributed *H. lacrymabundum* to Bulliard's figure 525 and thus started a tangle which has involved many names in this country and Europe. At first Fries regarded *H. velutinum* as a variety of *H. lacrymabundum*, but in his later publications (3) his more mature judgment gave each specific rank, and his own figure (4) plate 134, *fig.* 1 is good for the species as here admitted. The *H. lacrymabundum* described and illustrated by Patouillard (17) which he regarded as the Friesian plant is of the *H. velutinum* type, not the white pileate, smooth-spored form of Fries in his later works. Peck, who introduced the name into American literature, recognized a brown or tawny-brown plant with large spores, but failed to say whether the spores were rough or smooth. Ricken (22) and Murrill (13) recognized the large-spored dark form of the *H. velutinum* group as this plant, but Kauffman (8), Rea (21), and Harper (5) adopted the idea of Maire. Confusion exists both as to descriptions and illustrations in most of the popular works on mushrooms.

17. *HYPHOLOMA ECHINICEPS* Atkinson, Ann. Myc. 7: 370. 1909.

Pileus 3-10 cm. broad, convex, firm, fleshy, not hygrophane, ochraceous-brown, the center densely covered with pointed, seal-brown, more or less coarse, squarrose scales which become more or less distinct toward the margin; context at first white, changing to saffron-yellow; odor and taste mild; gills adnate,

slightly narrowed in front and rounded behind, rich purple-brown with Indian-purple tinge, the edge whitish; stem 10–14 cm. long, 8–12 mm. thick, even, hollow, fibrous with seal-brown scales below, white and yellow above; veil ample when young, forming appendiculate fragments on the margin and leaving an evanescent ring on the stem; spores $7-9 \times 3.5-5 \mu$, smooth, sub-elliptic, inequilateral, outer end at times slightly narrowed; cystidia on both sides and edge of gills, projecting up to 40μ , cylindric, 10–12 μ , diameter, straight to flexuous, in groups on the edge.

HABITAT: On the ground or about dead stumps or roots.

HABIT: Caespitose.

TYPE LOCALITY: Ithaca, New York.

DISTRIBUTION: New York.

This plant, may be altogether too close to *H. lacrymabundum*, Bull. ex Quél. with which it has been confused by Peck, to be considered as anything but a form of that species. Murrill regarded it as distinct, but possibly because it differs from the European *H. Storea* Fries, which he considers identical with the *H. lacrymabundum* of this country.

18. *HYPHOLOMA FRAGILE* Peck, Bull. N. Y. State Mus. 131: 22. 1909.

Pileus 1.2–2.4 cm. broad, thin, fragile, conic, or subcampanulate, becoming convex, obtuse, or sub-umbonate, not hygrophanous, yellowish, grayish, or sub-ochraceous, at times very highly colored on the center, floccosely squamulose when young, glabrous when mature, margin very thin, at first appendiculate with fragments of the white veil; context very thin, white; gills adnate, thin, narrow, close, whitish or pallid, becoming purplish-brown; stem 2.5–5 cm. long, 2–3 mm. thick, slender, fragile, stuffed or hollow, glabrous or minutely floccose, white or pallid; spores $6-7 \times 4-5 \mu$, smooth, ellipsoid to oblong-ellipsoid; cystidia none.

HABITAT: On decayed wood or among fallen leaves in damp places.

HABIT: Gregarious.

TYPE LOCALITY: Star Lake, St. Lawrence Co., New York.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATIONS: Peck, Bull. N. Y. State Mus. 131: fig. 1–7.

This delicate little plant bears resemblance to *H. appendiculatum* Bull. ex Fries or *H. incertum* Peck, but is smaller than either and differs from both in having no cystidia. It is not hygrophanous and its spores under the microscope are lighter brown in color.

19. *HYPHOLOMA CUTIFRACTUM* Peck, Bull. Torrey Club 22: 490. 1895.

Pileus 2.5–5 cm. broad, campanulate or expanded, not hygrophanous, grayish-buff, the disk at times darker, faintly striate at times, glabrous, commonly with the cuticle irregularly rimose, margin frequently deeply split; context very thin, white; gills adnate, thin, close, at first white or whitish, ecru-drab, later rose-brown; stem 7–10 cm. long, 3–6 mm. thick, hollow, slender, glabrous, white; spores $7.5\text{--}9.5 \times 4\text{--}5 \mu$, smooth, ellipsoid to oblong-ovoid, brown; cystidia none.

HABITAT: Base of poplar tree.

HABIT: Caespitose.

TYPE LOCALITY: Rooks Co., Kansas.

DISTRIBUTION: Kansas and California.

This species is in shape, size and color very close to *H. Candolleianum* Fries. Harper thinks that certain weather conditions are responsible for the cracking and splitting described by Peck. In his notes Peck says the pileus is not hygrophanous, thus removing it from the *Candolleianum-appendiculatum* group. Murrill places it with his *Drosophila appendiculata*, but the absence of cystidia, the larger spores and longer stem prevents such a disposition.

20. *HYPHOLOMA DELINEATUM* Peck, Bull. N. Y. State Mus. 150: 83. 1911.

Pileus 2.5–5 cm. broad, fleshy, convex, or nearly plane, often slightly depressed in the center, not hygrophanous, brown, tawny-brown, or reddish-brown, often darker on the center, glabrous, rugose or radiately wrinkled, commonly marked toward and on the margin when dry with irregular radiating lines or ridges, the margin occasionally wavy or irregular; context thin, whitish; gills adnate, thin, close, brown, becoming blackish-brown; stem 3–5 cm. long, 3–6 mm. thick, equal, hollow, glabrous, pallid or colored like the pileus; spores $8\text{--}9 \times 5\text{--}6 \mu$, smooth, ellipsoid to ovoid, not apiculate, purple-brown in color under the

microscope; cystidia on sides and edge of gills, hyaline, numerous, conspicuous, flask-shaped and sharp pointed, projecting 20–35 μ , 10–15 μ , in width.

HABITAT: On the ground or on decaying wood.

HABIT: Gregarious.

TYPE LOCALITY: Port Jefferson, Suffolk Co., New York.

DISTRIBUTION: Massachusetts, New York, West Virginia, Indiana, and Missouri.

This description is based upon the original by Peck, who says this species is likely to be mistaken for *H. rugocephalum* Atk., which it resembles externally, but from which it is separated by the more narrow, obtuse, and smooth spores, and the broader, flask-shaped, pointed cystidia. Its glabrous, rugosely and radiately wrinkled pileus and smooth spores separate it from *H. velutinum* Pers. ex Fries. The absence of spots and striations separates it from *H. lepiditum* Bres. After examining dried plants only, I am inclined to follow Harper in the belief that this species is identical with *H. lacrymabundum* Bull. ex Quél. Final disposition of Peck's species must await further collections and study of fresh material.

21. *HYPHOLOMA RADICOSUM* Lange, Danske Botanisk Arkiv. 4:
39. 1923.

(PLATE 29, FIG. 32)

Pileus 4–5 cm. broad, convex, or somewhat gibbous, dry, honey-ochraceous or tan, covered more or less with a whitish bloom, especially toward the margin; context thin, whitish, smell acrid, taste bitter; gills adnate, crowded, pallid, then fuscous-brown, edge whitish; stem 7–8 cm. long, 4–8 mm. thick, hollow or nearly so, fusiform, attenuated into a short or longer brown root, squamules sub-ferruginous, somewhat imbricate, or arranged in transverse zones, white above, fibrillose-scaly below, yellow within or ferruginous in the root; veil delicate, white, soon disappearing; spores 6.5–7 \times 4–5 μ , smooth, ellipsoid, or oval; cystidia on sides and edge of gills, hair-shaped, projecting 15–30 μ , 8–13 μ in width.

HABITAT: On rotten coniferous stumps (rarely on frondose stumps fide Lange).

HABIT: Solitary or in small fascicles.

TYPE LOCALITY: Denmark.

DISTRIBUTION: Maryland.

Professor Lange informed me that this species is quite common in Europe, and that he had collected it in New England during the summer of 1931. He regards it as identical with *H. epixanthum* Ricken (non Fries), and that it is the same plant which Rea describes as *Flammula inopoda*. On account of its non-hygrophanous character he doubts that it is identical with *Agaricus* (*Flammula*) *inopus* Fries. It is here admitted because Lange (10) seems to have clearly presented a heretofore hopelessly confused synonymy.

22. *HYPHOLOMA SUBLATERITIUM* Fries, Epicr. Syst. Myc. 221. 1838.

Agaricus (*Hypholoma*) *sublaterius* Fries, Epicr. Syst. Myc. 221. 1838.

Agaricus lateritius Schaeff. Fungi Bavar. Ind. 22. 1774.

Agaricus perplexus Peck, Ann. Rep. N. Y. State Cab. 23: 99. 1872.

Hypholoma perplexus (Peck) Sacc. Syll. Fung. 5: 1028. 1887.

(PLATE 26, FIG. 8)

Pileus 2.5–12 cm. broad, convex, becoming plane, obtuse, at times slightly umbonate, dry, not hygrophanous, usually dark brick-red or brown, darker on the center, lighter brown to yellowish on margin and especially when young, even except when it becomes irregular in crowded clusters, glabrous, frequently rimose, naked or covered with a very thin cobwebby coat when young, margin frequently decurved and adorned with the remnants of the veil; context thick, firm whitish or very light yellow, becoming more yellowish in age, odor not characteristic, taste mild; gills adnate, or adnexed, at times decurrent by faint lines on the stem, crowded, narrow, whitish, grayish to olive green, finally purplish-brown, edge finely crenate; veil delicately membranous, soon disappearing; stem 6–14 cm. long, 4–18 mm. thick, equal, or tapering downward, fibrillose, becoming glabrous, stuffed, or hollow, whitish above and faintly striate at times, ferruginous below; spores $6-8 \times 3-4 \mu$, smooth, oblong, or elliptic, rich purple-brown under the microscope; cystidia on sides of gills few, scattered, not conspicuous, projecting but slightly beyond the basidia, obclavate and apiculate, inflated on edge of gills, projecting 8–20 μ , in width.

HABITAT: On or about stumps or prostrate trees in woods and open places, occasionally from buried wood on lawns.

HABIT: Caespitose, rarely scattered.

TYPE LOCALITY: Bavaria.

DISTRIBUTION: Massachusetts, Connecticut, New York, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Alabama, Florida, Ohio, Michigan, Minnesota, Illinois, Missouri, Texas, Washington.

ILLUSTRATIONS: Cooke, Ill. Brit. Fungi *pl.* 557 [572]; Gillet, Champ. Fr. *pl.* 130; Hard, Mushr. *fig.* 265; Kauffman, Agar. Mich. 2: *pl.* 51; Marshall, Mushr. Book *pl.* 21, 23; Murrill, Mycologia 1: *pl.* 1, *fig.* 1; Patterson & Charles, Bull. U. S. Dept. Agr. 175: *pl.* 27, *fig.* 1; Schaeffer, Fung. Bavar. *pl.* 49, *fig.* 7; (as *Agaricus lateritius*); White, Bull. Conn. Geol. Nat. His. Surv. 3: *pl.* 25; and many others.

This is unquestionably the most common member of the genus during the autumn months. It is probably universal in its distribution. In the woods of Maryland, I have collected it from August to December and as early in the spring as April. In Pennsylvania I found it plentiful about stumps January 20th, 1932, after the ground had been twice covered with snow. It is the common edible "brick-top mushroom."

Var. PERPLEXUM (Peck) Kauffman, Agar. Mich. 1: 257. 1918.

This variety differs from the species in the color of the gills which are a tint of yellow rather than whitish in the young plants, and in the more slender stem which is hollow. In all other respects it is like *H. sublateritium*.

Var. SQUAMOSUM Cooke, Ill. Brit. Fungi, *pl.* 558 [573].

This variety differs from the species only in its delicate, floccose scales, which are arranged in concentric rows near the margin of the pileus. This European variety has been reported by Peck and by Atkinson. Peck saw it but once and says it is rare. It has been illustrated by Atkinson, Stud. Am. Fungi *pl.* 6, *fig.* 25; and better by Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 19.

23. *HYPHOLOMA FASCICULARE* Huds. ex Quél. Champ. Jura et Vosges 113. 1872.

Agaricus fascicularis Huds. Fl. Angl. ed. 2: 615. 1778.

Pileus 3–8 cm. broad, dry, convex to expanded, obtuse or umbonate, reddish on the disk, lemon, or sulphur-yellow toward the margin, smooth, glabrous, dry; context fleshy, firm, yellow, odor not distinctive, taste bitter; gills 3–5 mm. broad, adnate, crowded, linear, sulphur-yellow, greenish, finally olive-brown; stem 2–12 cm. long, 5–8 mm. thick, very variable in length, slender, hollow, flexuous, fibrillose, yellow; spores $6-7 \times 4-5 \mu$, smooth, ovoid to ellipsoid; cystidia on sides and edge of gills, cylindric, obtuse, at times blunt pointed, not conspicuous, projecting $6-14 \mu$, $8-10 \mu$ in width.

HABITAT: On or about dead wood (frondose stumps, fide Lange).

HABIT: Caespitose.

TYPE LOCALITY: England.

DISTRIBUTION: Colorado, California, Oregon, and Washington.

ILLUSTRATIONS: Cooke, Ill. Brit. Fungi. *pl.* 561 [576]; Gillet, Champ. Fr. *pl.* 131; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 75; Patouillard, Tab. Anal. Fungi 1, *fig.* 116; and many others.

This European plant seems to replace *H. sublateritium* Fries, as the most common form in those states west of the Rocky Mountains. It is also said to be very common in Europe.

24. *HYPHOLOMA CAPNOIDES* Fries, Syst. Myc. 1: 289. 1821.

Agaricus capnoides Fries, Obs. Myc. 2: 27. 1818.

(PLATE 26, FIG. 7; PLATE 31, FIG. 39)

Pileus 2.5–8 cm. broad, convex, or nearly plane, obtuse, not hygrophanous, yellowish with lighter margin and often with reddish, or ochraceous disk, glabrous, margin even; context white or whitish, taste and odor mild; gills adnate, dry, close, smoky-gray, becoming brown or purplish-brown; stem 4–8 cm. long, 4–6 mm. thick, hollow, equal, silky, striate at the apex, at times curved or flexuous in very young plants; spores $7-9 \times 4-5 \mu$, smooth, ellipsoid to ovoid, very light brown under the microscope; cystidia on sides of gills, clavate with prominent point, projecting $15-25 \mu$, $10-14 \mu$ in width.

HABITAT: On logs and stumps of coniferous trees.

HABIT: Solitary or caespitose.

TYPE LOCALITY: Sweden.

DISTRIBUTION: Massachusetts, New York, Pennsylvania, and Idaho.

ILLUSTRATIONS: Cooke, Ill. Brit. Fungi *pl.* 559 [574]; Fries, Ic. Hym. *pl.* 133, *fig.* 1; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 74; Ricken, Blätterp. Deutsch. 2: *pl.* 65, *fig.* 5.

This plant seems to be somewhat rare in the United States. Kauffman did not collect it at all in Michigan. I have found a single collection in Pennsylvania. It is very close to *H. sublateritium* Fries and *H. fasciculare* Huds. ex Quél. Our plant seems to differ from the form found commonly in Europe, in having a reddish or orange disk, and in not displaying the purplish tint in the gills.

25. *Hypholoma simile* sp. nov.

(PLATE 26, FIG. 6)

Pileus 2–3.5 cm. broad, fragile, hemispheric, then campanulate or convex, gray or often ochraceous or cinnamon-buff when young or on the disk, frequently cream colored, at times sub-viscid but usually dry, sub-glabrous or minutely tomentose, margin even or slightly rugose; context thin, concolorous or lighter; gills 3–5 mm. broad, adnate, easily separating, medium close, dark brown; stem 4–7 cm. long, 2–5 mm. thick, equal, glabrous above, white tomentose at base, even, smooth, hollow; spores 8.5–10.2 (–13) \times 5–5.3 μ , smooth, oblong-elliptic, to ovoid-elliptic, at times blunt on one end, deep brown under the microscope; cystidia rare on sides of gills, none on the edge, ventricose, sub-cylindric, sharp pointed, projecting 13.6–25 μ , 8–10.5 μ in width.

HABITAT: On ground along river bank.

HABIT: Gregarious.

TYPE LOCALITY: St. Charles, Missouri. (Overholts Herb. 1626).

DISTRIBUTION: Known only from the type locality.

This species was collected by Dr. L. O. Overholts. It greatly resembles the plants which Lange places in his *Psathyroide* group. In the color of its very large spores, its general shape and habitat, it seems distinct from other species except *H. delineatum* Peck. In its cystidial character and spore size, it may be too close to *H. delineatum* to justify specific rank.

Hypholoma simile. Pileo 2-3.5 cm. crassus, tenue, hemisphaerico, dein campanulato vel convexo, sordide albido, saepe ochraceo vel cinnamomeo, saepe subviscoso, sed plerumque sicco, subglabro vel pulverulento; lamellis 3-5 mm. crassus, adnatis, subconfertis nigro-fuscis; stipite 4-7 cm. longus, 2-5 mm. crassus, aequali, glabro, basi tomento; sporis 8.5-10.2 (-13) \times 5-5.3 μ , levi, oblongis-ellipsoideis; cystidia rare laterae lamellae.

26. *HYPHOLOMA PECKIANUM* Kauffman, Agar. Mich. 1: 258. 1918.

Pileus 1-2 cm. broad, convex, obtuse, sub-expanded, bay-brown, blackish on the disk, paler on the margin, viscid, glabrous, even, the margin bordered by white, silky fibrils from the veil; context whitish, moderately thin, thicker on disk, odor and taste none; gills 2-3 mm. broad, adnate, rounded behind, abruptly narrowed in front, close, flesh-colored at first, then dark purplish-brown, edge white fimbriate; stem 3-4 cm. long, 2-2.5 mm. thick, equal white floccose above, innately fimbriate below, pallid to brownish, brown within except the white pith, at length hollow, flexuous; veil white, distinctly fibrillose; spores 10-12 \times 5-6 μ , smooth, ventricose-elliptic, pointed at the ends, tinged purple under the microscope; basidia sub-cylindric, 30 \times 6 μ , 4-spored; cystidia on edge of gills only, linear-cylindric, obtuse, projecting about 20 μ , 4 μ in width.

HABITAT: On debris of leaves and decaying wood of hemlock, beech, and maple.

HABIT: Solitary.

TYPE LOCALITY: New Richmond, Michigan.

DISTRIBUTION: Known only from the type locality.

This description is based upon the original by Kauffman. I have examined the type collection and can add nothing to his description. The viscid nature of the pileus, its flesh-colored gills, and small size sets it apart as distinct.

27. *Hypholoma elongatipes* nom. nov.

Hypholoma longipes Dearness & Bisby, Fungi of Manitoba 113. 1929. (Not *H. longipes* Peck, Bull. Torrey Club 22: 204. 1895.)

Pileus 6-14 cm. broad, globose, then hemispheric, finally plano-convex, at times upturned on the margin and broadly umbonate, whitish with lavender tinge, then buff, drying buff to buckthorn-brown, radiately floccose-striate, especially toward the margin, viscid; context thin to the umbo, whitish, taste and odor

mild; gills adnate, or arcuate and adnate-decurrent by ridges on the stem, chocolate-brown, whitish at first, soon purplish and mottled, edge white fimbriate, not distilling droplets; stem 6–18 cm. long, 1–2 mm. thick, hollow, shining, concolorous or paler than the pileus, sometimes brownish-purple at the base, even, innately fibrillose, striate, easily splitting; veil whitish at first, evanescent, sometimes leaving remnants near the base of the stem; spores $9\text{--}12.5 \times 5\text{--}7 \mu$, smooth, sub-elliptic; cystidia clustered on edge of gills, sub-ventricose, often capitate, $55\text{--}75 \times 10\text{--}15 \mu$.

HABITAT: At or near the floor of an old "dug-out," whose walls and roof had been supported by poplar poles.

HABIT: Caespitose or single.

TYPE LOCALITY: Manitoba Agricultural College, Manitoba, Canada.

DISTRIBUTION: Known only from the type locality.

This description is based upon the original by the authors, who suggest the resemblance between this plant and *Psilocybe larga* Kauffm. but *P. larga* is hygrophanous and has cystidia on the sides of the gills.

28. *HYPHOLOMA RIGIDIPES* Peck, Bull. N. Y. State Mus. 139: 24. 1910.

Drosophila rigidipes (Peck) Murrill, Mycologia 14: 70. 1922.

Pileus 2.5–5 cm. broad, fleshy, thin, convex, or broadly convex, tawny-brown, often reddish on the disk, dry, fibrillose-squamulose; context whitish, taste mild; gills adnexed close, narrow, slightly sinuate, brownish-red, becoming dark purplish-brown or black; stem 5–10 cm. long, 4–6 mm. thick, slender, rigid, equal, hollow, fibrillose-squamulose, concolorous or a little paler than the pileus; spores $8\text{--}11 \times 5\text{--}6 \mu$, smooth or slightly warted when mature, elliptic or broadly-elliptic, almost black under the microscope; cystidia on sides of gills but scarce, sharp pointed, projecting $6\text{--}8 \mu$, on edge of gills cylindric, obtuse or acuminate, projecting $15\text{--}20 \mu$.

HABITAT: Damp places among tall herbs.

HABIT: Gregarious.

TYPE LOCALITY: North River, Warren Co., New York.

DISTRIBUTION: Massachusetts and New York.

In its spore characters this species seems closely related to *H. velutinum* Pers. ex Fries. It is a smaller plant and distinct in its slender, rigid stem, squamulose pileus and shape of cystidia.

29. *HYPHOLOMA BOUGHTONII* Peck, Ann. Rep. N. Y. State Mus. 139: 23. 1909.

(PLATE 26, FIG. 13; PLATE 27, FIG. 24; PLATE 30, FIG. 37)

Pileus 2.5–7 cm. broad, broadly convex, sub-hemispheric, occasionally with an umbo, not hygrophanous, pale reddish-brown, or grayish-brown, glabrous or innately fibrous, areolately or concentrically cracking, margin extended slightly beyond the gills; context thin, whitish, taste disagreeable; gills adnate, purplish-brown, seal-brown, or blackish, white floccose on the edge; veil only as remnants attached to the edge of the pileus in young plants, white; stem 2.5–6 cm. long, 4–10 mm. thick, equal, floccosely fibrillose, striate above, hollow, white or whitish; spores $8-10 \times 5-7 \mu$, tuberculate, broadly and equally elliptic to broadly ellipsoid, lemon-shaped, apiculate, dark-brown, opaque; cystidia present on the sides of the gills but exceedingly rare, flask-shaped projecting $6-11 \mu$, $8-10 \mu$ in width.

HABITAT: On the ground in woods and open grassy places.

HABIT: Solitary or caespitose.

TYPE LOCALITY: Menands, Albany Co., New York.

DISTRIBUTION: New York and Pennsylvania.

ILLUSTRATIONS: Harper, Trans. Wisc. Acad. Sci. 17: pl. 21, figs. a–c; Peck, Ann. Rep. N. Y. State Mus. 139: pl. 2.

In its microscopic characters this species can be easily confused with *H. rugocephalum* Atk. and a little less so with *H. velutinum* Pers. ex Fries. The three differ most in their external appearance. This species is a smaller plant, neither hygrophanous nor viscid, and is distinct in its usually concentrically cracked and frequently umbonate pileus. It is either without cystidia or those organs are exceedingly rare. *H. rugocephalum* has a rugose and at times sub-viscid pileus and cystidia are present though at times not conspicuous. From *H. velutinum*, it is more easily separated in the matter of the cystidia, which are numerous and conspicuous, and the radiately rugose, matted, fibrous pileus, which is also hygrophanous. The closest relationship between the three species rests in the shape, color, and size of the spores. In the type collections of the two American plants it is very difficult, if not impossible, to separate them. Additional study of fresh plants may result in combining this species with one or both of the others, but in the absence of full and complete

notes concerning these salient characters, which are more or less obscure in dried specimens, I prefer keeping this species distinct. See *H. velutinum* Pers. ex Fries for additional notes on this species.

30. *HYPHOLOMA RUGOCEPHALUM* Atkinson, Stud. Am. Fungi 30. 1901.

(PLATE 26, FIG. 11; PLATE 27, FIG. 25)

Pileus 5–10 cm. broad ovoid, later plane, or at times broadly umbonate, not hygrophanous, watery-brown to tawny or alutaceus-tan, at times dark orange-cinnamon, the margin usually somewhat lighter and inclined to olivaceous, dry, glabrous, irregularly to radiate-ribbed-rugose, margin curved upward; context thick on the disk, pallid but not white, odor none, taste mild; gills 5–9 mm. broad, adnate, seceding, close, pale brown, edge white, slightly fimbriate, black spotted; veil evident only in young specimens, later adhering to margin of pileus or leaving a few delicate fibrils on the stem; stem 9–12 cm. long, 6–12 mm. thick, equal, sub-bulbous, hollow, pale yellow or light brown, glabrous or floccose at apex, fibrillose below or frequently stained darker by the spores; spores $9\text{--}12 \times 5\text{--}9 \mu$, tuberculate, broadly elliptic, abruptly pointed or lemon-shaped, at times with a hyaline zone at the point or flattened on one side; cystidia on the sides of gills, not abundant, hyaline, flask-shaped, projecting up to $27\text{--}34 \mu$, but mostly $6.8\text{--}10 \mu$, less frequently clustered on the edge, projecting $20\text{--}30 \mu$.

HABITAT: Rich moist woods at base of stumps.

HABIT: Solitary or caespitose.

TYPE LOCALITY: Ithaca, New York.

DISTRIBUTION: New York, New Jersey, Pennsylvania, North Carolina, Michigan, Wisconsin, Illinois, and Missouri.

ILLUSTRATIONS: Atkinson, Stud. Am. Fungi *pl.* 8, *fig.* 29; Harper, Trans. Wisc. Acad. Sci. 17: *pl.* 20.

If this species, *H. Boughtonii* Peck, and *H. velutinum* Pers. ex Fries are identical, the original descriptions of the macroscopic characters are erroneous. The nature of the pilei in each case is different. At this time I am unwilling to combine the three for evidence from a number of collections of fresh material is essential before such a decision is made. I did not locate the cystidia in my first sections of either the type or the cotype specimens, and I have found no evidence of cystidia in the sections made by Dr.

Overholts in 1917, but upon making additional slides and after a very careful re-examination of a number of sections of type material, I have found them as described herein. I am unable to account for the "echinulate or minutely tuberculate" spore description by Atkinson, for all sections display spores as very rough walled. A discrepancy also exists in the literature as to the locality of the type collection. See *H. velutinum* Pers. ex Fries for additional notes on this species.

31. *HYPHOLOMA VELUTINUM* Pers. ex Fries, Syst. Myc. 1: 288. 1821.

Agaricus velutinus Pers. Syn. Fung. 409. 1801.

Agaricus lacrymabundus Bull. Herb. Fr. pl. 194. 1784.

(PLATE 31, FIG. 38)

Pileus 3–11 cm. broad, ovate to campanulate and finally plane, or at times obtusely umbonate, hygrophanous, cinnamon-buff to pinkish-buff or isabella, becoming clay-color to tawny-olive, darker in the center, young plants covered with a tomentum of adpressed fibrils or scales, soon glabrate, never striate, sometimes radiately rugose; margin of very young plants adorned with remnants of the veil, later splitting; context thick on the disk, soft, white, yellowish or very light brown, odor and taste mild; gills adnate, seceding, crowded, narrower toward the margin, sinuate, not reaching the margin of the pileus, yellow in young plants, later umber, dotted by the dark spores, the edge white floccose or beaded with drops of water; stem 2–13 cm. long, 4–15 mm. thick, equal or tapering slightly downward, soon hollow, fibrillose to floccose-scaly, tawny below, whitish and striate above; veil of soft matted fibers, soon breaking, dingy white; spores $8\text{--}13 \times 7\text{--}8 \mu$, tuberculate, oval to broadly elliptic, usually apiculate, very dark purplish-umber under the microscope; cystidia scattered on the sides of gills, very conspicuous, abundant in groups on the edge, cylindric-sub-capitate, projecting $28\text{--}48 \mu$.

HABITAT: Damp ground in rich humus in woods.

HABIT: Caespitose, gregarious, or rarely solitary.

TYPE LOCALITY: France.

DISTRIBUTION: Pennsylvania, Michigan, Illinois, and Missouri.

This very distinctive and variable European plant is unquestionably present in our flora and causing mycologists about as much trouble here as it has in Europe. *H. velutinum* Pers. ex Fries, *H. rugocephalum* Atk., and *H. Boughtonii* Peck are very

similar. They cannot be separated upon spore characters and the cystidia in general are the same. The cystidia, however, are far more abundant and conspicuous in this species. The character of the pileus in each case is different. This plant is the *H. lacrymabundum* of most authors. Lange (10), in his study of the genus *Hypholoma*, includes this species only "for practical reasons." He regards it as a distinct generic type, but follows Patouillard in placing it in a section *Lacrymaria*, based on the verrucose spores and almost black spore-print. Faint traces of purple can be seen in the almost black spore mass on white paper.

The characters which differentiate these three plants may be summarized as follows:

H. BOUGHTONII Peck

Pileus: 2.5-7 cm. broad, sub-hemispheric, occasionally with umbo, not hygrophanous reddish-brown to grayish-brown, glabrous or innately fibrous, concentrically cracking, taste disagreeable.

Stem: 2.5-6 cm. long, striate above, floccosely-fibrillose.

Cystidia: rare on sides of gills.

H. RUGOCEPHALUM Atkinson.

Pileus: 5-10 cm. broad, plane, not hygrophanous, watery-brown, alutaceus-tan or dark orange-cinnamon, glabrous, irregular to radiate-ribbed-rugose, taste mild.

Stem: 9-12 cm. long, floccose at apex.

Cystidia: rare on sides of gills, clustered on edge of gills.

H. VELUTINUM Pers. ex Fries.

Pileus: 3-11 cm. broad, campanulate or plane, hygrophanous, cinnamon-buff, isabella, clay-color or tawny-olive, tomentose with adpressed fibrils or scales, taste mild.

Spores: 2-13 cm. long, striate above, fibrillose or floccose-scaly.

Cystidia: conspicuous on sides and edge of gills.

32. *HYPHOLOMA CAMPANULATUM* Peck, Bull. Torrey Club 36: 336. 1909.

Drosophila campanulata (Peck) Murrill, Mycologia 4: 304. 1912.

Pileus 3-4 cm. broad, campanulate, ochraceous, dry, somewhat shining, glabrous, at times slightly appendiculate with fragments of the white veil; context thin; gills nearly free, thin, close, pale brown, becoming dark brown, whitish on the edge; stem 8-13 cm. long, 4-7 mm. thick, equal, hollow, glabrous, white or cream with a soft, white tomentum at the base; veil white; spores 9-11 \times 6-8 μ , smooth, ellipsoid-oblong, light brown; cystidia absent.

HABITAT: Open ground among grass, weeds, and shrubs.

HABIT: Caespitose or gregarious.

TYPE LOCALITY: Claremont, California.

DISTRIBUTION: California.

This description is based upon the original. The spores were found to be larger and not exceptionally dark as described. It is very closely related to *H. longipes* Peck. An examination of a number of collections probably might prove this to be only a small form of *H. longipes*. Peck's notes indicate that his collection, made by C. F. Baker, might better be assigned to the genus *Panaeolus*.

33. *HYPHOLOMA LONGIPES* Peck, Bull. Torrey Club 22: 204. 1895.

Drosophila longipes (Peck) Murrill, Mycologia 4: 303. 1912.

Pileus 2.5-3 cm. broad, campanulate, hygrophanous, yellowish-brown when moist, brown or isabelline-brown when dry, fibrillose becoming glabrous, even or obscurely striate on the margin, which is appendiculate with the very delicate, white, floccose, fugacious veil; context very thin, pallid; gills adnate, narrow, close, white or whitish, becoming nearly black, frequently white fimbriate on the edge; stem 5-12.5 cm. long, 2-5 mm. thick, slender, hollow, striate at apex, arising from white mycelioid tomentum at base; spores 10-12.5 \times 6-8 μ , smooth, elliptic to elliptic-ellipsoid, light purple-brown under the microscope; cystidia none.

HABITAT: Among fallen leaves.

HABIT: Gregarious.

TYPE LOCALITY: Pasadena, California.

DISTRIBUTION: Known only from the type locality.

This species seems to be the western form of *H. incertum* Peck, from which it differs in the elongated stem, which is so completely hollow to the apex as to form an umbo or depression in the center of all dried plants. It also has larger spores and cystidia are absent.

34. *HYPHOLOMA ATRIFOLIUM* Peck, Bull. Torrey Club 23: 417. 1916.

Pileus 1-5 cm. broad, convex, or hemispheric, then broadly convex, commonly umbonate, hygrophanous, burnt-umber or wood-brown when moist, fading to pale tawny or cream color in drying, glabrous, sub-membranous, minutely and irregularly furrowed, striate on the disk when mature, margin even; context thin; gills adnate, sub-distant, pale-brown to drab, then dark seal-brown or almost black; stem 2.5-6.5 cm. long, 2-3 mm. thick, slender, fibrillose, hollow, pallid or cream-color; veil fugacious; spores $7.6-10.2 \times 5-6 \mu$, smooth, broadly ellipsoid, very dark brown under the microscope; cystidia only on sides of gills, prominent but not numerous, cylindric to flask-shaped, projecting 10-13.6 μ .

HABITAT: Under *Salix* and *Ceanothus* in mountains of California.

HABIT: Gregarious or loosely caespitose.

TYPE LOCALITY: California.

DISTRIBUTION: California.

This description is based upon the original and notes by Peck. Two collections have been examined either one of which might have been the type. The spores proved to be ellipsoid to ovoid and slightly larger than described by Peck.

35. *HYPHOLOMA INOCYBEFORME* Kauffman, Papers Mich. Acad. Sci. 11: 193. 1929.

Pileus 2.5-4 (-5) cm. broad, fleshy, brittle, campanulate, sub-expanded, or repand, broadly umbonate, hygrophanous, cream-buff when young, chamois when older but still moist, paler when dry, even entirely glabrous, only the extreme margin provided with small, appendiculate, white and evanescent veil-remnants; context thin except on disk, concolorous, scissile, odor none or slightly aromatic, taste slight; gills 2.5-3.5 mm. broad, narrowly adnate, crowded, white at first, slowly pale avellaneous to grayish, edge minutely flocculose; stem 4-6 (-7) cm. long, 5-6 mm. thick, equal, white or hyaline-white, apex lacerate-scurfy, minutely silky-floccose at apex, concolorous within; spores $7-8 \times 4-4.5 \mu$, smooth, oblong, rounded-obtuse at ends, bright, brownish-purple under microscope; cystidia only on edge of gills, 42-46 μ long, 10-14 μ broad, saccate-clavate, tapering to slender pedicel, rounded at apex, hyaline, thin walled.

HABITAT: Along roadside bank of clay soil in conifer and oak forest.

HABIT: Gregarious.

TYPE LOCALITY: Takilma, Oregon.

DISTRIBUTION: Known only from the type locality.

This species is distinct in its lack of cystidia on the sides of the gills and in the clavate, sterile cells on the edge, pale color and broad umbo. The delicate, snow-white, appendiculate veil-remnants are seen only in young, partly-expanded plants. The wet pileus sometimes becomes radiately rugose on drying. The shape, color (especially of the gills), and habit suggest an *Inocybe*; the spore color and appendiculate pileus show it to be a *Hypoholoma*.

36. *HYPHOLOMA TSUGICOLUM* Kauffman, Papers Mich. Acad. Sci. 5: 133. 1925.

Pileus 3-7 cm. broad, convex, then sub-expanded, discoid, finally depressed on the disk, hygrophanous, buckthorn-brown to ochraceous-tawny when moist, yellow-ochre to antimony-yellow when dry, sub-viscid, with a separable subgelatinous pellicle; margin at first incurved, later elevated, very thin and acute, pellucid-long-striatulate, narrowly appendiculate from the veil; context thin, pliant, thicker on the disk, concolorous, fading; gills 5-7 mm. broad, adnate, sub-decurrent, close, narrow, almost linear, soon ochraceous-tawny with a darker sheen by reflected light, edge entire; stem 5-8 cm. long, 5-10 mm. thick, tapering downward, apex conspicuously dilated in the region of gill attachment, the surface at first with scurf-like scales up to the obsolete annulus, longitudinally fibrillose above, snuff-brown within and without; veil very scanty, white; spores 6-7 \times 4-4.5 μ , smooth, short-ellipsoid, purplish-brown under the microscope, darker in mass; cystidia indistinct on edge of gills; basidia 4-spored, 32 \times 4-5 μ .

HABITAT: On dead hemlock stump.

HABIT: Caespitose.

TYPE LOCALITY: Hood River, Oregon.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATION: Kauffman, Papers Mich. Acad. Sci. 5: *pl.* 8.

This plant was collected by Dr. C. H. Kauffman and the above description and notes are based upon the original by him. Very

few viscid or pelliculose species of *Hypholoma* have been described. This one differs from *H. incomptum* Masee of England, in the more ferruginous color, different gill attachment, and narrower spores.

37. *Hypholoma maculatum* sp. nov.

Pileus 4–8.5 cm. broad, convex to expanded, depressed in age, dry, clove-brown to bone-brown, tomentose over the center, cuticle separating into large, fibrous, appressed scales radiately arranged, margin incurved, exposing the whitish flesh of the pileus between the fibrous patches, appendiculate with large fragments of the brownish veil; context thin, whitish, taste and odor not distinctive; gills adnate, emarginate, drab, then dark purple-brown, the edge whitish; stem 4–10 cm. long, 6–12 mm. thick, hollow, white, covered with a bone-brown, fibrous layer below, white, and striate above; spores $3.5\text{--}5 \times 3.5 \mu$, smooth, ellipsoid, at times flattened on one side; cystidia on side of gills, ventricose, sub-cylindric, and very pointed, projecting 20–27.5 μ , clustered on edge, sub-cylindric, bottle-shaped.

HABITAT: On decaying log of *Alnus*.

HABIT: Gregarious or caespitose.

TYPE LOCALITY: Mt. Rainier National Park, Washington. (Herbarium Cornell University 25553.)

DISTRIBUTION: Known only from the type locality.

The above description was made from field notes of Atkinson, who collected the plant, but did not give it a name. This species is distinct in the nature of its pileus, especially, when considered in connection with the cystidial characters and the size of the spores. It cannot be easily confused with any other species.

Hypholoma maculatum. Pileo 4–8.5 cm. crassus, e convexo explanato, saepe depresso aetate maturitaste, sicco, fusco, tomento a centro, cuticula separans squama magnus am fibratam adpressam, margine involuto, pilei exponens carnosem albam; lamellis adnatis, emarginatae, e cinereo-brunneis fusco-purpureis; stipite 4–10 cm. longus, 6–12 mm. crassus, cavo, albo, apice striato; sporis $3.5\text{--}5 \times 3.5 \mu$ ellipsoideis, saepe unis planis lateris; cystidia laterae lamellae 20–27.5, subcylindraceo, cuspidate uva orae lamellis.

38. *HYPHOLOMA CANOCEPS* Kauffman, Papers Mich. Acad. Sci. 5: 134. 1925.

Pileus 1–2 cm. broad, about 1 cm. high, fragile, conical-campanulate to broadly conic, hygrophanous, cinnamon-drab

when moist, but this ground color almost hidden except on umbo by appressed, radially disposed, white, villous, innate, silkiness, slowly fading, at length sub-glabrescent, margin at first straight, appressed silky, not at all rounded behind, crowded, cinnamon-drab, white flocculose on edge; stem 4-6 cm. long, 2.5-3 mm. thick, equal, hollow, rather cartilaginous; white, fragile, straight or curved at base, even, at first covered by a rather persistent white silky floccosity, at length glabrescent, whitish within; spores $8-9.5 \times 3.5-4.5 \mu$, smooth, elliptic-oblong, sub-obtuse, purplish-brown; cystidia on sides of gills only, $40-50 \times 8-12 \mu$, neck about 4μ in diameter, short, ventricose, sub-globose above the pedicel with abrupt, narrow, cylindric neck, thin walled, hyaline.

HABITAT: On very rotten pieces of wood mixed with alluvial, moist soil in conifer forest.

HABIT: Gregarious.

TYPE LOCALITY: Mt. Hood, Oregon.

DISTRIBUTION: Known only from the type locality.

Kauffman regarded this species as a connecting link between *Hypholoma* and *Psathyra* because it combines the cartilaginous stem and straight pileus margin of *Psathyra* with the universal veil character of *Hypholoma*.

39. *HYPHOLOMA CALIFORNICUM* Earle, Bull. N. Y. Bot. Gard. 2: 344. 1902.

Drosophila californica (Earle) Murrill, Mycologia 4: 304. 1912.

Pileus 5-5.5 cm. broad, convex then expanded and sub-umbonate, hygrophanous, deep rich brown, smooth, atomate, margin entire, striate in dried specimens; context thin, pale brownish, unchanging, odor mild, taste not characteristic; gills adnexed or sub-free, sub-crowded, slightly ventricose, pale brown at first, then darker; stem 7-10 cm. long, 4-5 mm. thick, equal, hollow, glabrous above, flocculose below, uneven with irregular swellings, sordid-white, marked with brownish stains upon drying, cartilaginous, fragile, often splitting; spores $6-7 \times 3-4 \mu$, smooth, ovate, cylindric-oval, or ellipsoid; cystidia scattered on sides of gills, not numerous, clustered on edge, projecting $20-22 \mu$, $6-8 \mu$ broad, hyaline, mostly bottle-shaped, few cylindric.

HABITAT: In coniferous forest.

TYPE LOCALITY: Palo Alto, California.

DISTRIBUTION: California.

This species was collected by C. F. Baker. The above-description is based on the original description by Earle and an examination of the cotype found in the Cornell University herbarium.

SYNONYMS, DOUBTFUL AND EXCLUDED SPECIES

Hypholoma aggregatum sericeum Peck, Bull. N. Y. State Mus. 54: 965. 1902.

This description is based upon a collection from North Bolton, New York, which I regard as too close to *H. lacrymabundum* Bull. ex Fries emend Quelet for separation.

Hypholoma ambiguum Peck, Bull. Torrey Club 25: 325. 1898.
Transferred to *Stropharia ambigua* (Peck) Zeller, Mycologia 6: 3. 1914.

Hypholoma Artemisiae Passerini, Nuova. Giorn. Bot. Ital. 4: 82. 1872.

Reported by Peck as occurring in New York (Ann. Rep. N. Y. State Mus. 32: 29. 1879) but not included in his monograph of New York species, and not otherwise reported.

Hypholoma comaropsis Mont. Syll. Crypt. 122. 1856.

Described from Ohio, but not since collected or recognized by mycologists from that state.

Hypholoma comatium Atkinson, Proc. Am. Phil. Soc. 57: 355. 1918.

I did not see the type specimen nor other collections of this species.

Hypholoma dispersum Fries, Epicr. Syst. Myc. 222. 1838.

Hypholoma elaeodes Fries, Epicr. Syst. Myc. 222. 1938.

Hypholoma epixanthum Fries, Epicr. Syst. Myc. 222. 1838.

These three European plants have been reported in our literature but it is very doubtful whether the plants actually occur here.

Hypholoma flocculentum McClatchie, Proc. So. Calif. Acad. Sci. 2: 381. 1897.

I have seen no plants of this species and the description reveals no characters distinct from *H. appendiculatum* (Bull.) Fries.

Hypholoma gracile Clements & Clements, Cryptogamae formation Coloradensium 387. 1906.

The general shape, size, color of the spores, and shape of the cystidia suggest other than this genus. It is probably a *Psathyra*.

Hypholoma hirtosquamulosus Peck, Ann. Rep. N. Y. State Mus. 25: 79. 1873.

This plant has not the appearance of a *Hypholoma*. The type sheet bears the note by Peck "Not a good *Hypholoma*." He excluded it from his monograph of New York species.

Hypholoma hydrophilum (sense of Saccardo) Kauffman, Agar. Mich. 1: 266. 1918.

Plants which do not well satisfy the specific description are thus classified by Kauffman. His plants differ in that the "pileus is at first sprinkled over its surface with white, floccose, particles or minute scales, even on the margin when moist; stem fibrillose-flocculose, glabrescent; spores $7-8 \times 4-5 \mu$, slightly unequally elliptical; cystidia on sides of gills scattered to somewhat numerous, ventricose-sublanceolate but obtuse, about 50μ long; sterile cells pyriform-inflated, numerous on edge of gills."

Harper also reports a plant under this name which bears spores $3-5 \times 7-9 \mu$ and has dart-shaped, colored cystidia. The two plants are not identical though Harper so inferred. I am at this time inclined to place the Kauffman plant among the variants of *H. Candolleianum* Fries, of which my herbarium contains three forms, and to reject the Harper specimen on the nature of its cystidia.

Hypholoma leucotephrum Berk & Br. Ann. Mag. Nat. His. IV. 4: 6. 1870.

Reported by Harper as occurring at Sumner, Washington and Geneseo, Illinois. My examination of the dried specimens in his collection suggests that this plant might well be placed among the *H. Candolleianum* Fries, variants.

Hypholoma marginatum Pers. ex Fries, Epicr. Syst. Myc. 292. 1838.

This name was regarded as a synonym of *H. dispersum* Fries by Fries. It was introduced into American Literature without accompanying specimens by Morgan (Jour. Myc. 14: 32. 1908).

Hypholoma modestum Peck, Ann. Rep. N. Y. State Mus. 32: 29. 1879.

This description was based on a collection from the Adirondack Mountains. I found neither the type nor additional mention of

the species in Peck's notes at Albany, and he excluded it from his monograph.

Agaricus (Hypholoma) nitidipes Peck, Ann. Rep. N. Y. State Mus. 35: 133. 1884.

Hypholoma nitidipes (Peck) Sacc. Syll. Fung. 5: 1031. 1887.

This species was excluded from his monograph and marked on the type sheet by Peck "*Pholiota duroides*."

Agaricus (Hypholoma) ornellus Peck, Ann. Rep. N. Y. State Mus. 34: 42. 1883.

Transferred to *Pholiota ornella* by Peck, Bull. N. Y. State Mus. 122: 151. 1908.

Agaricus (Hypholoma) saccharinophilus Peck, Ann. Rep. N. Y. State Mus. 25: 78. 1873.

This plant was rejected by Peck in his monograph of New York species. It is here excluded on account of the spore color, which is regarded as too light.

Hypholoma saccharinophilum Peck, Kauffman, Agar. Mich. 1: 268. 1918.

This name excluded by Peck in his monograph of New York species was revived by Kauffman and applied to a Michigan species. Examination of the Peck type and Kauffman's specimens leads me to conclude that they are not identical plants. The Kauffman plant is here described as *H. cinereum*.

Hypholoma squalidellum Peck, Ann. Rep. N. Y. State Mus. 29: 40. 1878.

Transferred to *Psilocybe* by Peck, Ann. Rep. N. Y. State Mus. 44: 56. 1893.

Hypholoma subaquilium Banning, Ann. Rep. N. Y. State Mus. 44: 182. 1891.

This plant was collected at Druid Hill Park, Baltimore, Md. It is probably *H. appendiculatum* Bull. ex Fries. It has never since been reported.

THE PENNA. STATE COLLEGE,
STATE COLLEGE, PA.

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INDEX TO SPECIES

New species are printed in full face; synonyms and non-valid binomials *italics*; previously published valid names in lower case Roman

	PAGE		PAGE
<i>Agaricus</i>		<i>Bolbitius</i>	
<i>capnoides</i>	194	<i>hydrophilus</i>	181
<i>fascicularis</i>	194		
<i>hydrophilus</i>	181	<i>Drosophila</i>	
<i>incertus</i>	178	<i>californica</i>	206
<i>lacrymabundus</i>	200	<i>campanulata</i>	201
<i>lateritius</i>	192	<i>hololanigera</i>	180
<i>ninidipes</i>	209	<i>longipes</i>	202
<i>ornellus</i>	209	<i>rigidipes</i>	197
<i>perplexus</i>	192		
<i>saccharinophilus</i>	209	<i>Hypholoma</i>	
<i>sublateritius</i>	192	<i>aggratum</i>	186
<i>velutinus</i>	200	<i>aggregatum</i> var. <i>sericeum</i>	207

PAGE	PAGE
<i>ambiguum</i> 207	<i>hymenoccephalum</i> 173
<i>appendiculatum</i> 183	<i>incertum</i> 178
<i>artifolium</i> 203	<i>inocybeforme</i> 203
<i>artimisiae</i> 207	<i>irregulare</i> 174
<i>Boughtonii</i> 198	<i>lacrymabundum</i> 187
<i>californicum</i> 206	<i>leucotephrum</i> 208
<i>camaropsis</i> 207	<i>longipes</i> 202
<i>campanulatum</i> 201	<i>longipes</i> Dearness & Bisby 196
<i>Candolleianum</i> 177	<i>maculatum</i> 205
<i>canoceps</i> 205	<i>madeodiscum</i> 182
<i>capnoides</i> 194	<i>marginatum</i> 208
<i>catarium</i> 174	<i>modestum</i> 208
<i>cinereum</i> 175	<i>nitidipes</i> 209
<i>comatum</i> 207	<i>oblongisporum</i> 179
<i>coronatum</i> 176	<i>Peckianum</i> 196
<i>cutifractum</i> 190	<i>perplexus</i> 192
<i>delineatum</i> 190	<i>var. perplexum</i> 193
<i>dispersum</i> 207	<i>populinum</i> Britz. var. 174
<i>echiniceps</i> 188	<i>radicosum</i> 191
<i>elaeodes</i> 207	<i>rigidipes</i> 197
<i>elongatipes</i> 196	<i>rugeocephalum</i> 199
<i>epixanthum</i> 207	<i>rugoproximum</i> 186
<i>fasciculare</i> 194	<i>saccharinophilum</i> 209
<i>flocculentum</i> 183	<i>simile</i> 195
<i>fragile</i> 189	<i>squalidelthum</i> 209
<i>gracile</i> 207	<i>var. squamosum</i> 193
<i>hirtosquamulosus</i> 208	<i>subaquilium</i> 209
<i>hololanigerum</i> 180	<i>sublateritium</i> 192
<i>hydrophilum</i> 181	<i>tsugicolum</i> 204
<i>hydrophilum</i> (sense of Saccardo) 208	<i>velutinum</i> 200
	<i>vinosum</i> 185

EXPLANATION OF PLATES

PLATE 26

Fig. 1, *H. rugoproximum* Parker, section of edge of gills showing a group of imbedded cystidia. From type specimen. $\times 700$; 2, *H. catarium* Fries, section of hymenium showing basidia, spores and cystidia. $\times 700$; 3, *H. irregulare* Parker, section of hymenium showing basidia, irregular spores, and cystidia. From the type specimen. $\times 700$; 4, *H. oblongisporum* Parker, section of the hymenium showing basidia, spores, and cystidia. From the type specimen. $\times 700$; 5, *H. appendiculatum* Bull. ex Fries, section of hymenium showing basidia, spores and cystidia. Cystidia are frequently observed in a more or less collapsed condition as indicated by cystidium on right. $\times 700$; 6, *H. simile* Parker, section of hymenium showing basidia, spores and cystidia. From the type specimen. $\times 700$; 7, *H. capnoides* Fries, section of hymenium showing basidia, spores and cystidia. $\times 700$; 8, *H. sublateritium* Fries, section of hymenium showing basidia, spores and cystidia. Shaded but not stippled cells represent the dark brown bodies which are usually in a state of collapse. $\times 700$; 9, *H. incertum* Peck, section of edge of gill showing basidia, spores and cystidia. From the type specimen. $\times 700$; 10, *H. hydrophilum* Bull. ex Fries, section of hymenium showing basidia, spores, and cystidia on sides and edge of gills. $\times 700$; 11, *H. rugeocephalum* Atk., section of hymenium showing basidia, spores and cystidia. From type specimen. The two very long

cystidia at right are rare in this species and seldom found. $\times 700$; 12, *H. Candolleianum* Fries, section of hymenium showing basidia, spores, and cystidia. $\times 700$; 13, *H. Boughtonii* Peck, section of hymenium showing basidia, spores, and cystidia. From the type specimen. $\times 700$.

PLATE 27

Photomicrographs of the spores of *Hypholoma* species with magnification indicated. Fig. 14, *H. hymenoccephalum* Peck, from the type specimen. $\times 440$; 15, *H. irregulare* Parker, from the type specimen. $\times 500$; 16, *H. cinereum* Parker, from the type specimen. $\times 580$; 17, *H. coronatum* Fries. $\times 500$; 18, *H. Candolleianum* Fries. $\times 440$; 19, *H. incertum* Peck, from the type specimen. $\times 500$; 20, *H. oblongisporum* Parker, from the type specimen. $\times 500$; 21, *H. hololanigerum* Atk. $\times 440$; 22, *H. hydrophilum* Bull. ex Fries. $\times 500$; 23, *H. rugoproximum* Parker, from the type specimen. $\times 500$; 24, *H. Boughtonii* Peck, from the type specimen. $\times 500$; 25, *H. rugocephalum* Atk., from the type specimen. $\times 500$.

PLATE 28

Fig. 26, *Hypholoma madeodiscum* Peck, showing the white gills, the nature and breaking of the veil and the hygrophanous character of the pilei. $\times 1/2$; 27, *Hypholoma appendiculatum* Bull. ex Fries. $\times 1/3$; 28, *Hypholoma hydrophilum* Bull. ex Fries, showing habit of growth and hygrophanous character of the pilei. $\times 2/3$; 29, *Hypholoma Candolleianum* Fries. $\times 1/2$.

PLATE 29

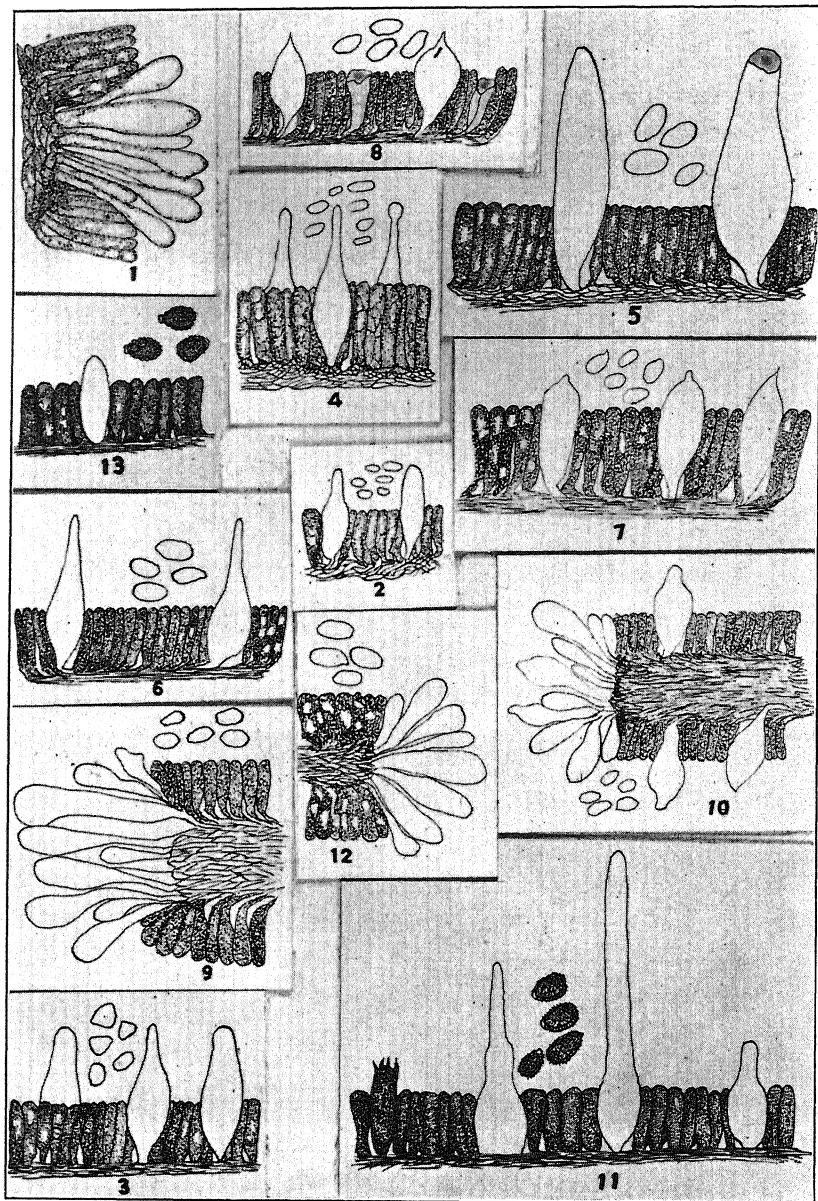
Fig. 30, *Hypholoma oblongisporum* Parker, showing habit of growth and veil character on young plants. $\times 2/3$; 31, *Hypholoma catarium* Fries, showing structure of plants. Actual size; 32, *Hypholoma radicosum* Lange, displaying the root. Actual size.

PLATE 30

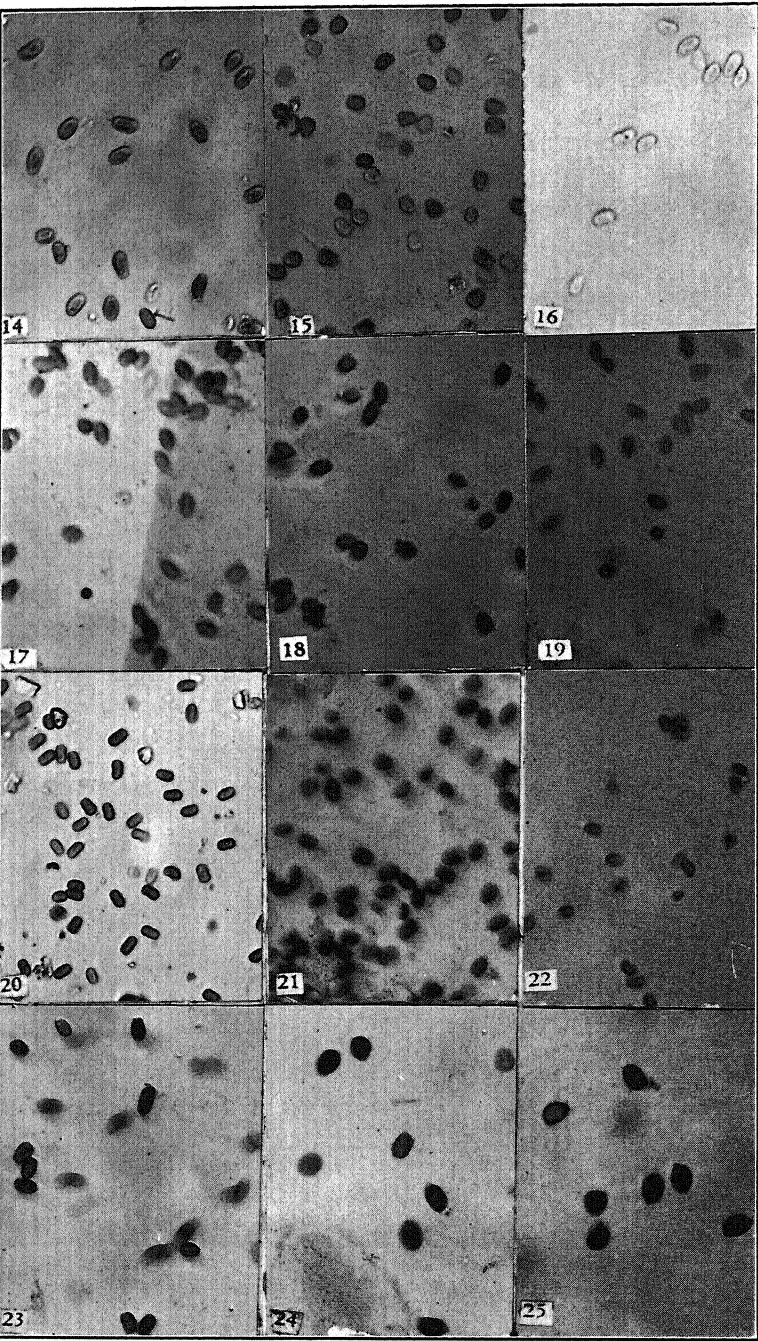
Fig. 33, *Hypholoma incertum* Peck, showing the white gill character in young plant. $\times 2/3$; 34, *Hypholoma cinereum* Parker, showing habit of growth. $\times 2/3$; 35, *Hypholoma rugoproximum* Parker, showing the structure of the pileus and habit of growth. Copy of photo by Dr. G. F. Atkinson. $\times 2/3$; 36, *Hypholoma hydrophilum* Bull. ex Fries, showing character of gills and stem striation. Actual size; 37, *Hypholoma Boughtonii* Peck, showing concentrically cracking pileus. $\times 3/4$.

PLATE 31

Fig. 38, *Hypholoma velutinum* Pers. ex Fries, showing the habit of growth and gill character. $\times 4/5$; 39, *Hypholoma capnoides* Fries, displaying habit of growth, character of the veil, structure of the stem and pilei. $\times 1/2$.

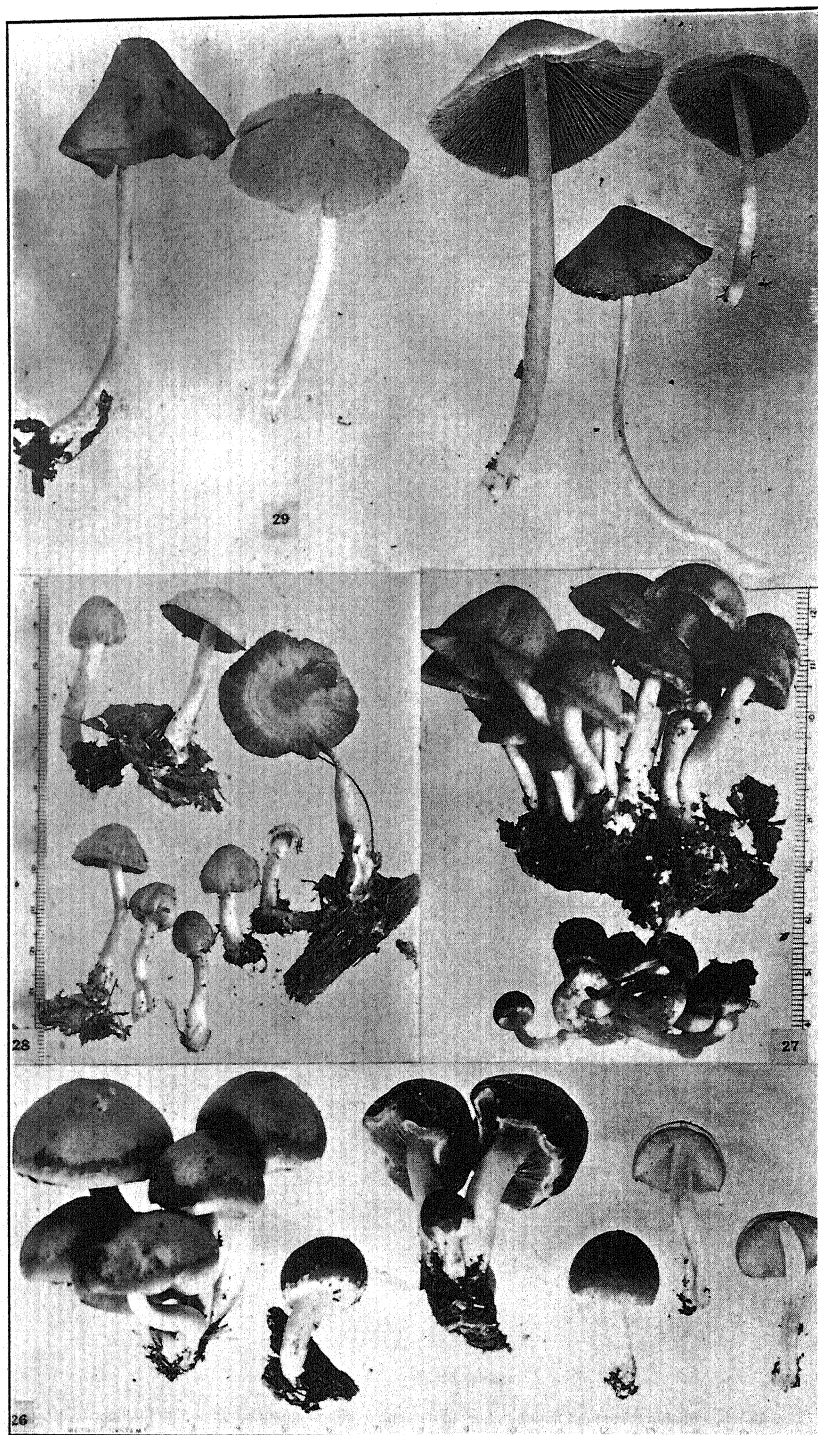


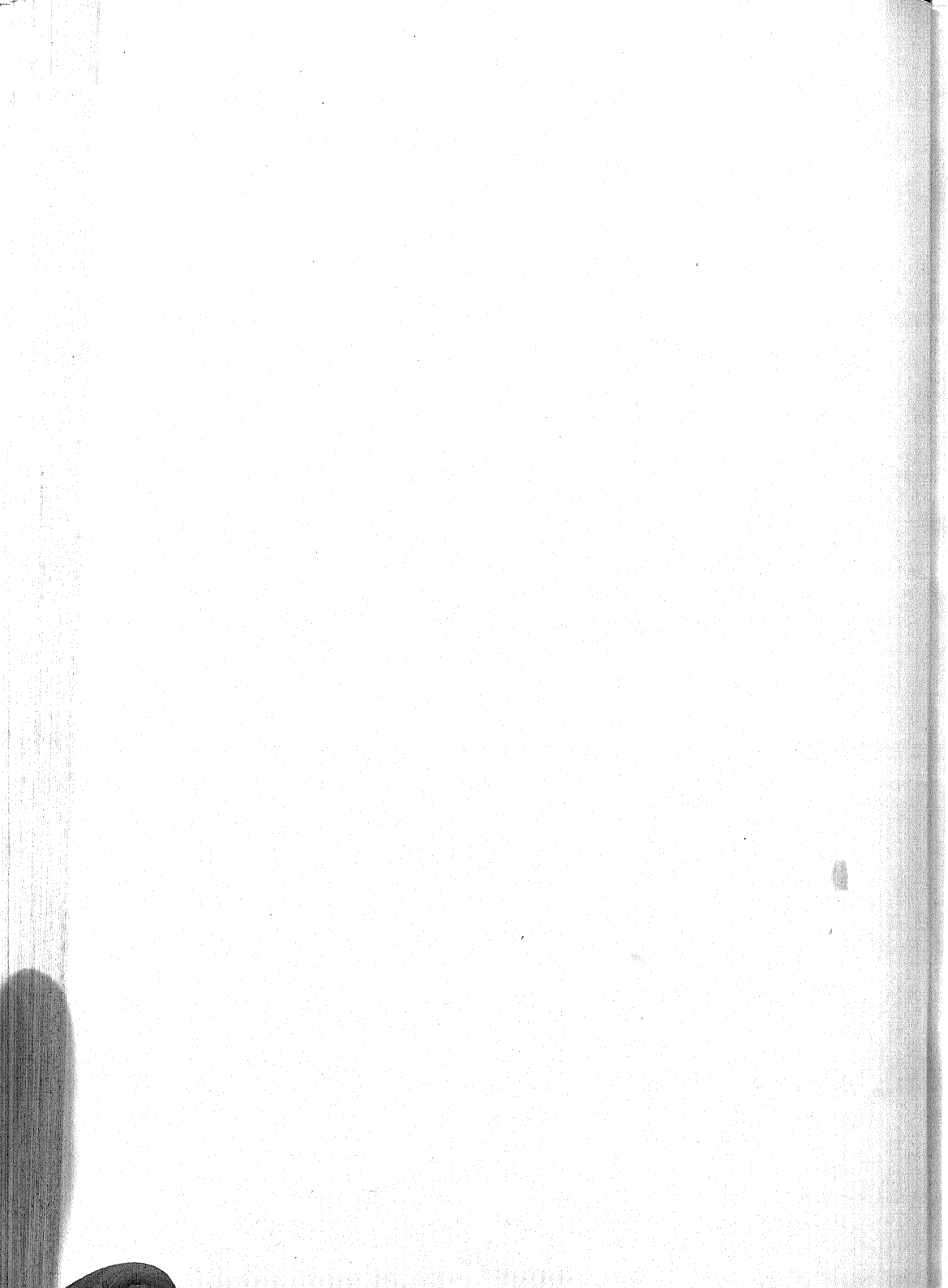
HYPHOLOMA

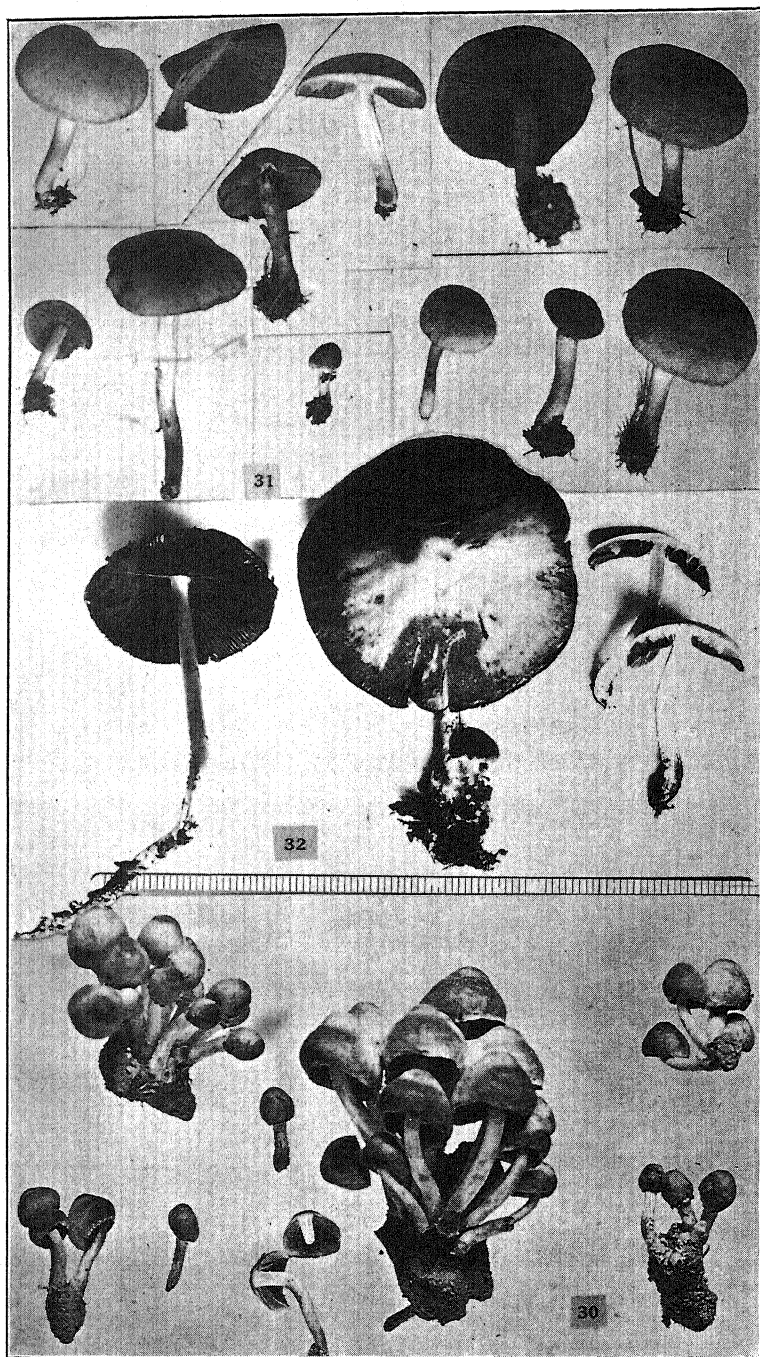


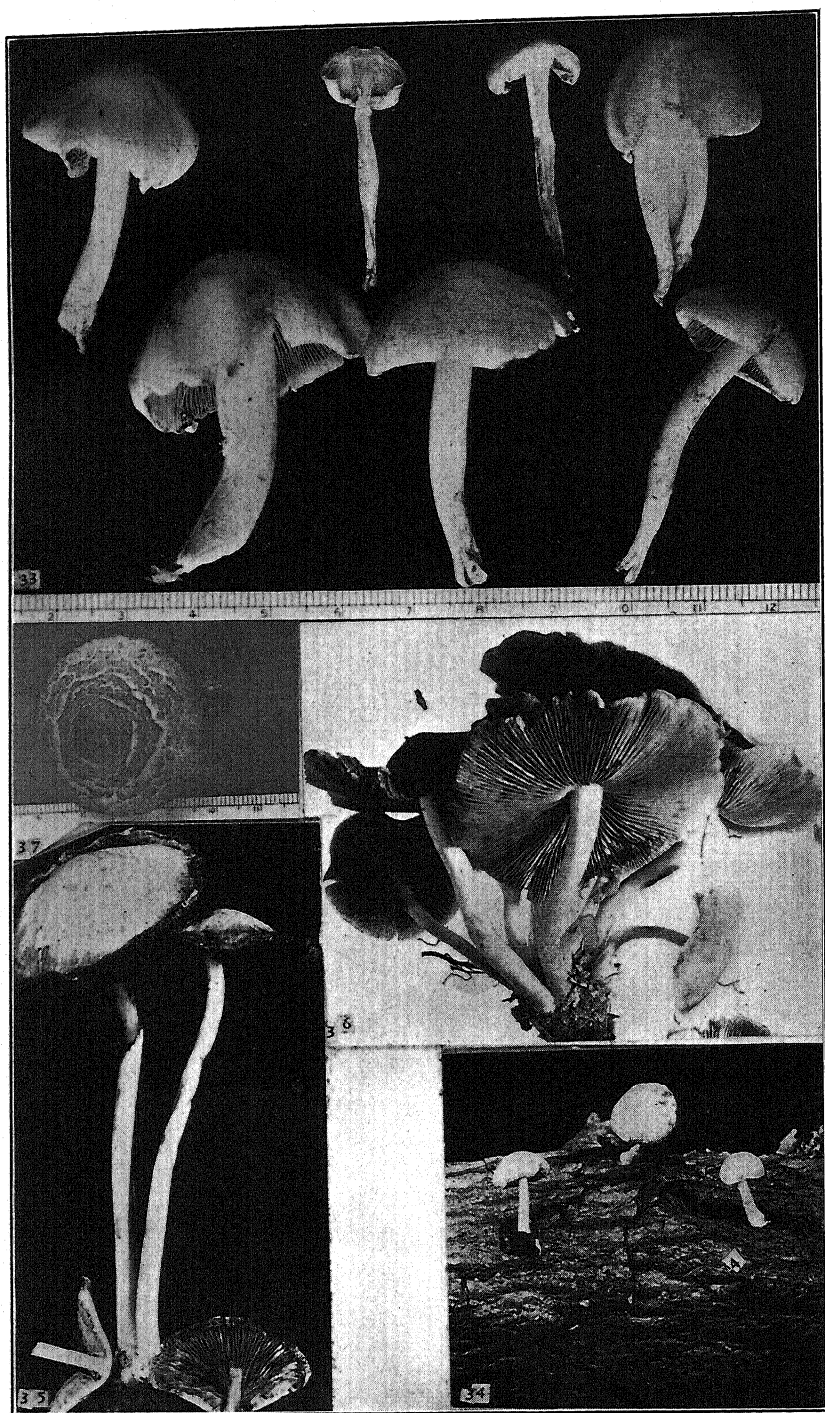
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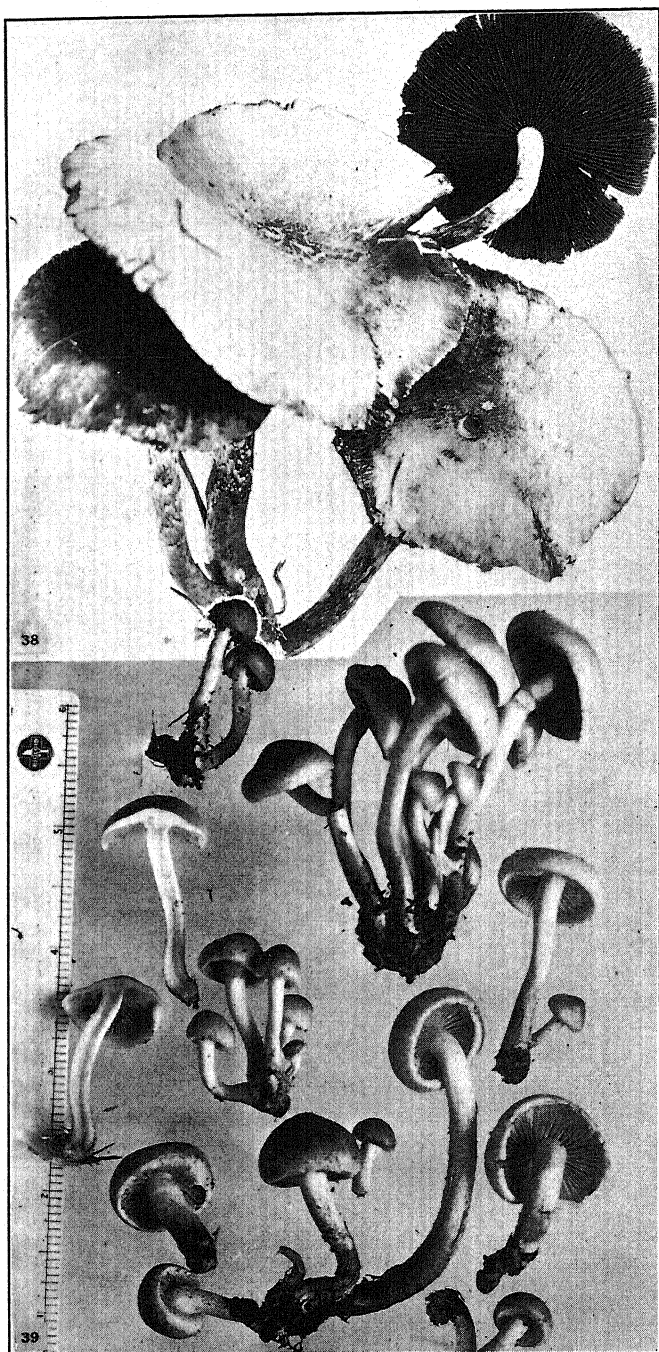




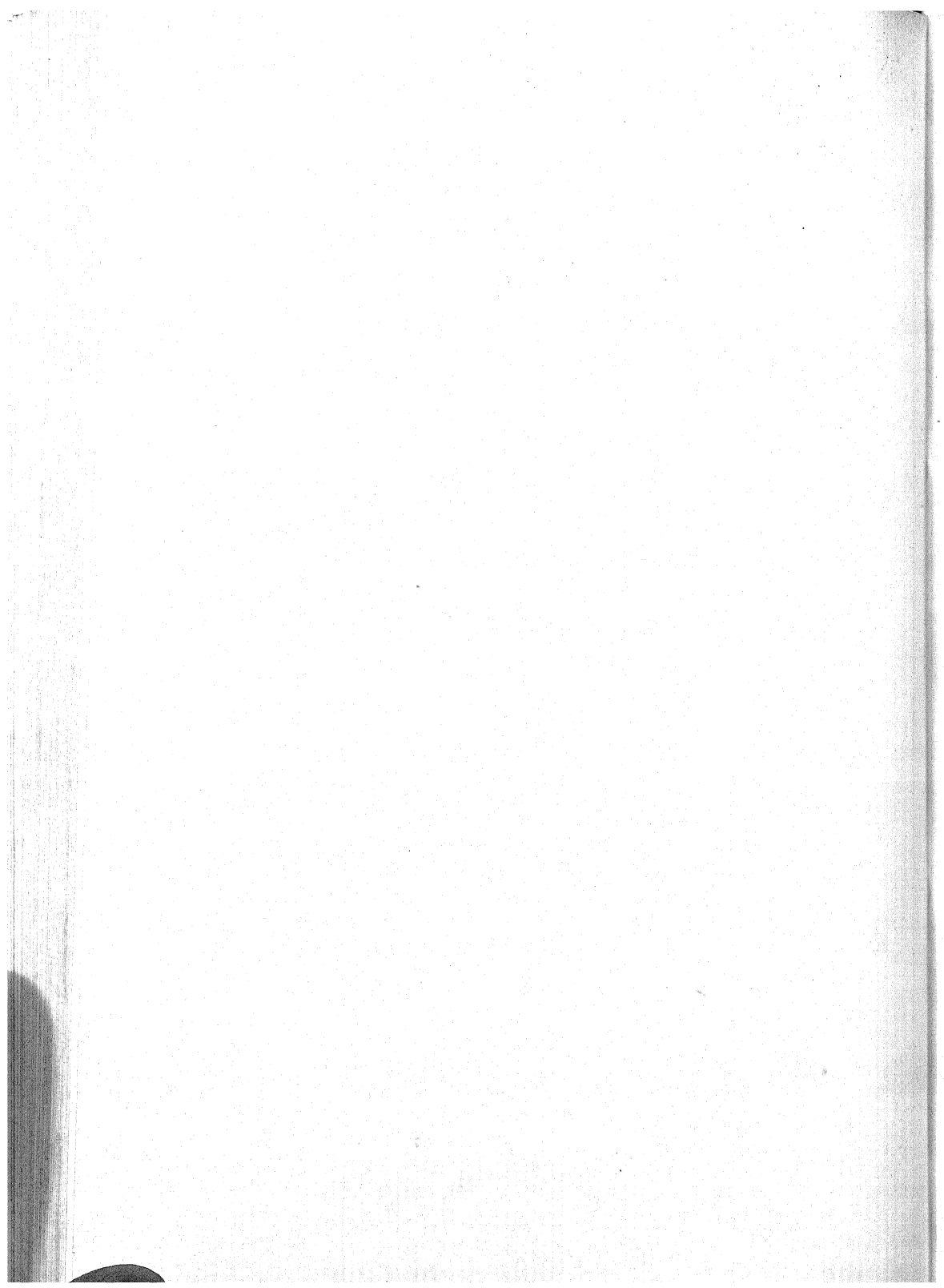


HYPHOLOMA





HYPHOLOMA



ADDITIONAL STUDIES OF SPECIES OF ELSINOE AND SPHACELOMA

ANNA E. JENKINS¹

(WITH PLATES 32 AND 33)

INTRODUCTION

Additional studies dealing particularly with the identity, history, and host and geographic range of members of the ascomycetous genus *Elsinoe* and the form genus *Sphaceloma*, representing the conidial stage of this genus so far as known, are reported in this paper.

SPHACELOMA ON POPLAR AND ON STRAWBERRY-TREE

Plate 32, A-F, represents typical material of *Hadrotrichum?* *Populi* Sacc.² on *Populus nigra* on the basis of which this fungus was classified as *Sphaceloma Populi* (Sacc.) Jenkins (5). A and B show the appearance of the leaf spot, C-E, acervuli on the upper surface of these lesions, and F, Briosi and Cavares's³ line drawing of this fungus. As previously mentioned (5) the organism has been reported only in Europe and South America. In autumn, 1931, poplar growing in Eastern United States was examined for the presence of this fungus but none was found.

In connection with the study of *Sphaceloma Populi* typical material of *Hadrotrichum Populi* Sacc. forma *Arbuti* Briosi & Cav.,⁴ occurring on strawberry-tree (*Arbutus Unedo* L.) in Italy (PLATE 33, A), was examined, and found to be also of the genus *Sphaceloma*. Comparison of the fungus with typical material of

¹ This opportunity is taken to thank Mr. C. A. Weatherby, of the Gray Herbarium, Harvard University, Mr. Percy Wilson, of The New York Botanical Garden, Dr. F. W. Pennell, of the Philadelphia Academy of Natural Sciences, and Mr. W. R. Maxon, of the U. S. National Herbarium, through whose courtesies infected leaves of the phanerogamic specimens cited in this paper have been obtained for further study and record. This material has been inserted in the mycological collections of the Bureau of Plant Industry.

² Saccardo, P. A. *Mycotheca veneta*. Century 13, No. 1256. (8, p. 264.)

³ Briosi, G. & Cavara, F. *I funghi parassiti delle piante coltivate od utili*. Fasc. 6, No. 139.

⁴ Briosi, G. & Cavara, F. *I funghi parassiti delle piante coltivate od utili*. Fasc. 14, No. 349.

the earlier described species, *Illosporium mattirolianum* Sacc. & D. Sacc.,⁵ on the same host (PLATE 33, B), showed that these two fungi are identical. This *Sphaceloma* is therefore referred to as *S. mattirolianum*.

What appear to be microconidia of this fungus, as reported in the original description, and also noted by Ferraris (2, p. 45 and figs. 5 to 8), were seen in sections from both these specimens. In some cases these apparent microconidia were within the more or less disrupted epidermis and in others they were in exposed pycnidia-like structures that were associated with the acervuli and sporodochia of the fungus. More or less the same phenomena have been observed by Tai (10) in *Myriangium Bambusae* Rick.

Sphaceloma mattirolianum has been found on leaves of two phanerogamic herbarium specimens of *Arbutus Unedo*, one from Germany⁶ and the other from Italy.⁷

SPHACELOMA ON LABRADOR-TEA

The occurrence of *Elsinoe* on Labrador-tea (*Ledum*) was learned indirectly from Prof. S. M. Zeller, of the Oregon Agricultural Experiment Station, in 1930 when he wrote Dr. C. L. Shear, of the Bureau of Plant Industry, United States Department of Agriculture, regarding the identity of a fungus found on *L. glandulosum* in that State. Dr. Shear, in turn, consulted the writer, who, knowing of the occurrence of *Sphaceloma mattirolianum* on the related genus *Arbutus*, as previously referred to, began a search for a published description of a member of the group occurring on *Ledum*. Peck's (7) description of *Aulographum Ledi*⁸ on *L. groenlandicum* was doubtless correct for the

⁵ Saccardo, D. *Mycotheca italica*. Century 8, No. 798. Padova, 1901.

⁶ Germany, Stuttgart, Charles Mohr 686. From Herbarium of Charles Mohr, presented to Smithsonian Institution, 1901. In U. S. National Herbarium, Washington, D. C., as No. 770,617.

⁷ Italy (Istria), Pola, Dec. 10, 1899, K. Untchj. In U. S. National Herbarium as No. 980,338.

⁸ "Aulographum ledi n. sp.

"Spots orbicular, grayish white, surrounded by a brown or purplish brown border; perithecia epiphyllous, few on a spot, elliptic or oblong, often substellately lobed by confluence, erumpent, black, context whitish; asci obovate or subglobose; spores ovate or oblong, continuous, at length uniseptate, hyaline, 12-15 μ long, 6-8 μ thick.

"Upper surface of leaves of Labrador tea, *Ledum groenlandicum* Oeder., Fine, St. Lawrence Co. August.

"Remarkable and very distinct by its subglobose asci."

fungus in question, as was verified by a fragment of the type⁹ (PLATE 33, D) kindly contributed in January, 1931, by Dr. H. D. House, State botanist, Albany, N. Y. This material shows both the perfect and the imperfect (*Sphaceloma*) stages of the fungus, although only the perfect stage was previously known. The writer was given a previously unidentified specimen of the fungus collected in Minnesota¹⁰ by Doctor Shear. The known range of the organism was further increased by the discovery of the characteristic lesions it causes on dried phanerogamic material of *Ledum glandulosum* Nutt. from California,¹¹ of *L. columbianum* Piper from Oregon,¹² and of *L. groenlandicum* Oeder from Pennsylvania¹³ (PLATE 33, C). Specimens from Oregon, received from Professor Zeller in February, 1931, were in agreement with the material of *Aulographum Ledi* just referred to. Both stages of the fungus were present. These facts, together with the other data just given, were transmitted to Professor Zeller, who made the new combination *Elsinoe Ledi* (Peck) Zeller (11).

In September, 1931, the writer examined two additional specimens of *Aulographum Ledi*, i.e., *Elsinoe Ledi*: A second specimen collected by Peck in the Adirondack Mountains,¹⁴ and a specimen from Newfoundland.¹⁵ On the latter specimen, in the handwriting of the late W. G. Farlow, professor of cryptogamic botany at Harvard University, appears the following notation pertaining to this fungus. "Peck gives spores as 2-celled but on *Ledum*

⁹ New York, St. Lawrence Co., Fine, Aug. 6, 1910, C. H. Peck. In Peck Herbarium, New York State Museum, Albany, N. Y.

¹⁰ Minnesota, Meadowlands, on *Ledum groenlandicum* Oeder, Aug. 21, 1914, C. L. Shear.

¹¹ California, Mendocino Co., Aug. 7, 1882, C. G. Pringle; June, 1903, Jas. McMurphy 84; May 26, 1913, P. Monnet. All in U. S. National Herbarium.

¹² Oregon, near Noti, Nov. 1914, Eugene Armstrong; sphagnum bog south of Waldport, Apr. 20, 1918, E. W. Lawrence 1286. In U. S. National Herbarium.

¹³ Pennsylvania, North Mountain, borders of Lake Leigh, July 19, 1897, C. F. Saunders. In U. S. National Herbarium.

¹⁴ New York, Sandlake, September (year not given), C. H. Peck. In Peck Herbarium. (Separate specimen in envelope with specimen labeled "*Lophodermium sphaerioides* (A. and S.) Duby.")

¹⁵ Newfoundland, St. John's, Bally Hally bog, on *Ledum groenlandicum* Oeder (syn. *L. latifolium* Ait.), Aug. 4, 1894, B. L. Robinson and H. Schrenk. In Farlow Herbarium, Harvard Cryptogamic Laboratories, Harvard University, Cambridge, Mass.

latifolium they are here 4-celled. Asci, $28 \times 17 \mu$, nearly spherical, spores hyaline 4-celled, $12-14 \times 6 \mu$." The fungus was observed also on additional phanerogamic specimens of *Ledum groenlandicum*, from Maine,¹⁶ New York,¹⁷ and Pennsylvania.¹⁸ It will be noted that the phanerogamic specimen from the Adirondacks antedates Peck's (7) discovery of the fungus there in 1910. Fructifications of the imperfect stage, and, in most cases, also of the perfect, have been present on all the material examined.

Elsinoe Ledi was isolated in April, 1931, from recently collected Oregon specimens on leaves and stems of *Ledum glandulosum* sent by Zeller. At a relatively high but variable room temperature, the new isolation is of slower growth than is usual for *Elsinoe* or *Sphaceloma*. At this temperature it grows more slowly than other species of *Elsinoe* or *Sphaceloma*. In one set of 2-weeks-old cultures on potato dextrose agar, colonies of *Sphaceloma* from *Ledum* were only about 2 mm. in diameter, while those of other species of *Elsinoe* or *Sphaceloma* were from 5 mm. to 10 mm. in diameter. In cultures grown on this medium for 3 weeks at constant temperatures of 0°, 5°, 10°, 15°, 20°, 25° C. and also at room temperature, the *E. Ledi* culture produced no growth at 0° C., only slight growth at 5° C., the largest amount of growth at 15° and 20° C., and somewhat more growth at 25° C., than at room temperature. The other species of *Elsinoe* or *Sphaceloma* produced a small amount of growth at 5° C. and the largest amount at 20° and 25° C. and at room temperature. From these comparisons, it seems that the optimum temperature range for *E. Ledi* is lower than that for the other species of *Sphaceloma* thus far isolated and that its slow rate of growth at room temperature may be explained on the basis of the unfavorably high tempera-

¹⁶ Maine, Aroostook County, Valley of Meduxnick River, July 13, 1916, M. L. Fernald and Bayard Long. In Philadelphia Academy of Natural Sciences.

¹⁷ New York, Great Otter Lake, western foothills of the Adirondacks, Brown's tract. From herbarium of O. R. Willis. In The New York Botanical Garden, presented in 1903.

¹⁸ Pennsylvania, Monroe County, on the Tunkhannock near Naomi Pines, June 8, 1889, T. C. Porter; Sullivan County, Sept. 14, 1897. From herbarium of Joseph Crawford; bog, Lake Leigh, Luzerne County, Aug. 26, 1896, Brown and Krout. All in Philadelphia Academy of Natural Sciences.

ture in this environment. It should be mentioned, however, that, even under favorable conditions *E. Ledi* evidently grows less rapidly than most of the other species of *Elsinoe* or *Sphaceloma* with which it was compared; for even at 15° and 20° C., it produced less growth than did practically all the other species at 20° and 25° C. and at room temperature. The 3-months-old slant culture on malt-agar-medium shown in plate 33, E, was grown for the first few weeks at room temperature and then at about 8° C. In coloration it was fuscous¹⁹ with a center of coral red and a margin of Verona brown. The 2-weeks-old cultures of this fungus on potato-dextrose agar previously referred to were Sanford's brown. The inoculum for the cultures here described consisted of cultural growth, about 0.5 mm. in diameter, transferred from a stock culture.

SPHACELOMA ON SNOWBERRY

Sphaceloma Symphoricarpi Barrus and Horsfall (1) on snowberry (*Symphoricarpos albus* (L.) Blake var. *laevigatus* (Fernald) Blake) was discovered at Geneva, N. Y., by F. C. Stewart, of the New York (Geneva) Agricultural Experiment Station. Specimens collected by him (9) on July 1 and on September 2, 1908,²⁰ have recently been examined by the writer. This fungus, originally reported as *Gloeosporium?* sp. (9), was only recently recognized (1) as a *Sphaceloma*, on the basis of its cultural characteristics. A culture contributed by Barrus and Horsfall, who first isolated the organism (1), produces on potato-dextrose-agar media, for example, the type of growth that has been described (4) as the pulvinate type in this genus.

Barrus and Horsfall (1) reported *Sphaceloma Symphoricarpi* on snowberry in New York, Arkansas, Iowa, and Wisconsin; Le

¹⁹ Color readings by J. Marion Shull, based on the following publication: Ridgway, R., "Color standards and color nomenclature." 43 p., illus. Washington, D. C. 1912.

²⁰ New York, Geneva, July 1, 1908, F. C. Stewart, in Peck Herbarium as *Gloeosporium* sp., and, according to Stewart, in Herbarium, N. Y. (Geneva) Agricultural Experiment Station, as *Gloeosporium* sp., identified by C. H. Peck; and Sept. 2, 1908, F. C. Stewart, in Herbarium, N. Y. (Geneva) Agricultural Experiment Station as *Gloeosporium* sp. Fragments of the former specimen, contributed by Doctor House, and of the latter, contributed by Professor Stewart, have recently been inserted in the Mycological Collections of the Bureau of Plant Industry.

Clerg (6) reported it in Colorado; and the writer (3) has found it in Maryland. The occurrence of the fungus in Maine, Virginia, and California was recently ascertained through examination of dried phanerogamic herbarium specimens of snowberry from these States.^{21,22,23}

In New York, in addition to Geneva (9), *Sphaceloma Symphoricarpi* has been reported on snowberry from Ithaca (1), Walton (1), and Fishkill (3). The snowberry planting at Walton is known to be over 50 years old, and that at Fishkill, situated on a mountain top, is not of recent date. When the latter planting was discovered, in 1928, snowberry plants in the region at the foot of the mountain were, and still are, free from the disease. A planting on the slope of the mountain, but not transplanted from the mountain top planting, is also anthracnose-free. Plantings observed elsewhere in New York, and also in Massachusetts, Connecticut, Pennsylvania, New Jersey, and Washington, D. C., during the growing season of 1931 were free from this disease.

Although snowberry is common in England, no *Sphaceloma* was observed on it there in the growing season of 1930 by Shear, White, or Jenkins. White also reports the absence of the fungus on snowberry examined in nurseries in France during this time.

SUMMARY

This paper presents data on the identity, history, and host and geographic range of members of the genus *Elsinoe* and of the form genus *Sphaceloma*. The Italian fungus, *Hadrotrichum Populi* var. *Arbuti*, is recognized as a *Sphaceloma* and as a synonym of *Illosporium mattirolianum*, and the new combination of *S. mattirolianum* made. Typical lesions produced by this fungus are present on phanerogamic herbarium specimens from Germany, showing that the organism is distributed in that country. Data on the history, identity and distribution of the American species, *Elsinoe Ledi* on Labrador tea, including studies leading to the discovery that the organism was described by Peck as *Aulo-*

²¹ Maine, Brooklin (Naskeag Point), Aug. 21, 1918, A. F. Hill. In Gray Herbarium, Harvard University, Cambridge, Mass.

²² Virginia, Rockingham County, Aug. 7, 1893, A. Heller and E. Gertrude Halbach. In Philadelphia Academy of Natural Sciences.

²³ California, Sonoma County, June 24, 1902, H. A. Heller 5762. In The New York Botanical Garden and in Philadelphia Academy of Natural Sciences.

graphum Ledi, are reported. In cultures of this organism grown on potato-dextrose agar medium, at the constant temperatures of 0°, 5°, 10°, 15°, 20°, and 25° C., and at room temperature *E. Ledi* produced optimum growth at 15° and 20° C., while other species of *Elsinoe* or *Sphaceloma* produced optimum growth at 20° and 25° C. and at room temperature. The distribution of *Sphaceloma Symphoricarpi* on snowberry in Maine, Virginia, and California was ascertained through examination of dried phanogamic herbarium specimens of snowberry from these states.

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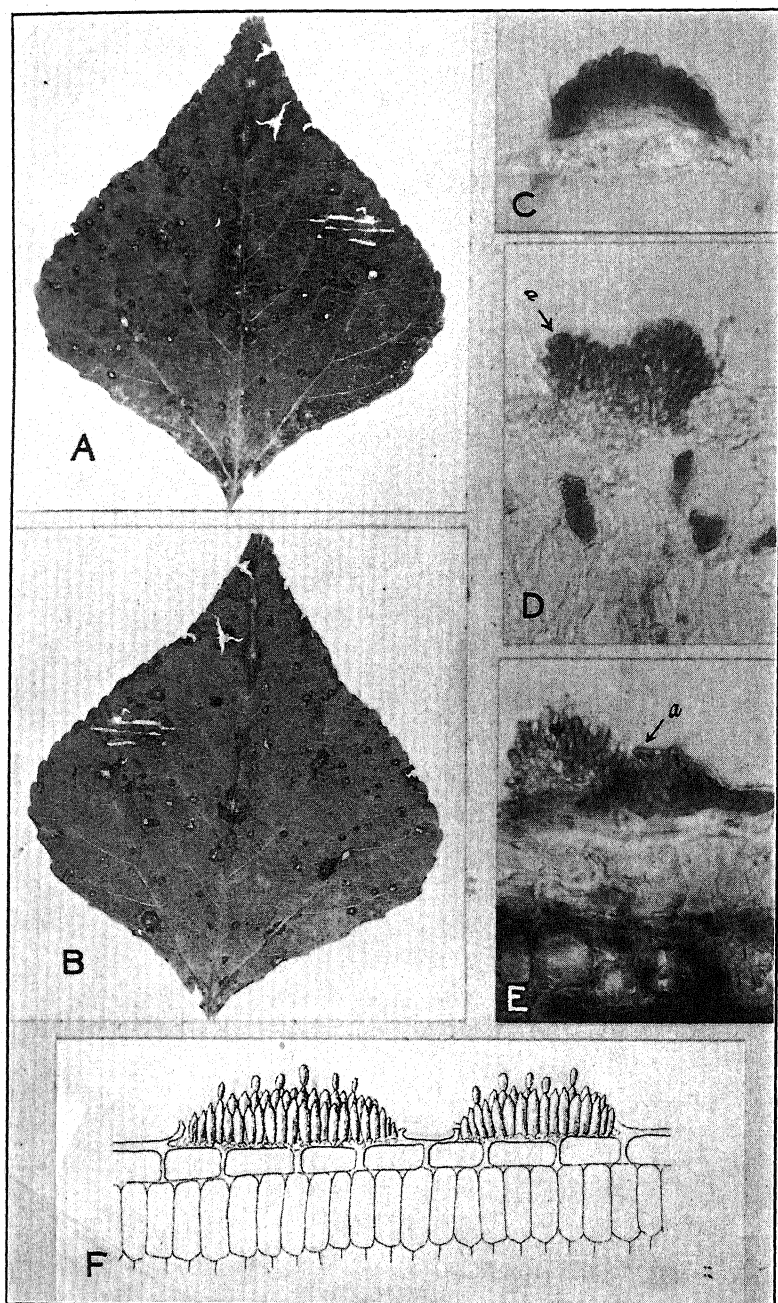
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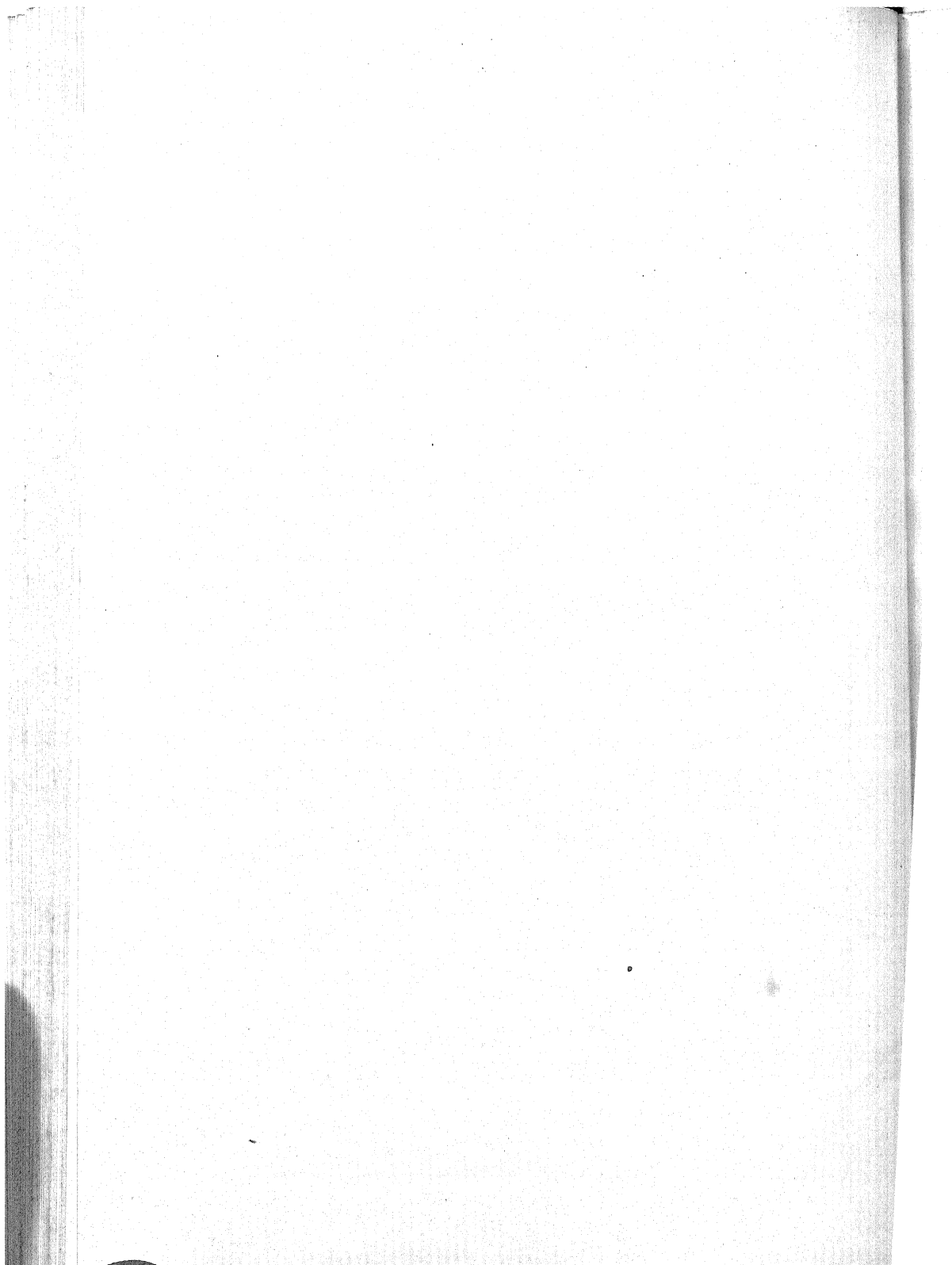
EXPLANATION OF PLATES

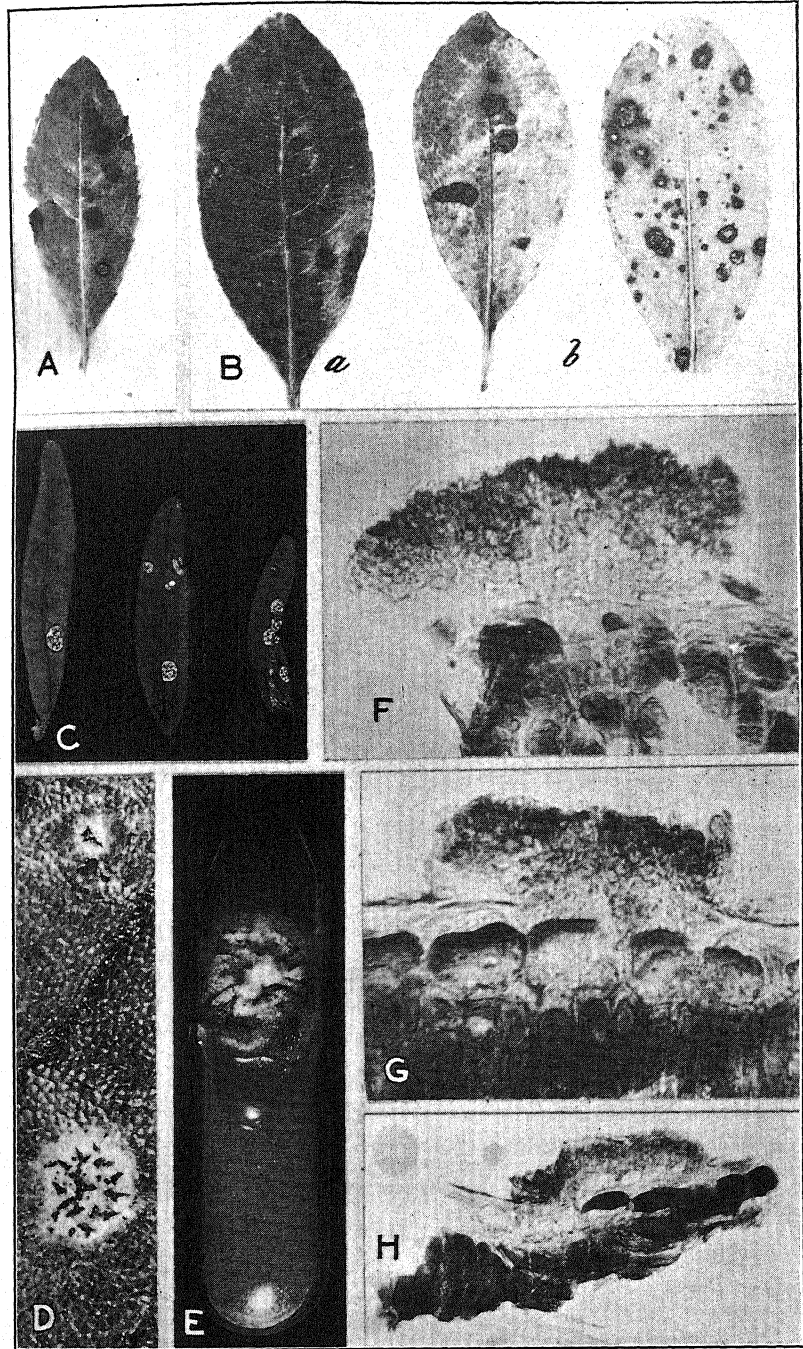
Plate 32. *Sphaceloma Populi* on *Populus nigra*, from Selva, Italy, October, 1877 (Saccardo, P. A., *Mycotheca veneta*. Century 13, No. 1256 (8, p. 264) (type)). A, Upper, and B, lower leaf surface showing appearance of leaf spot ($\times 1$); C-E, acervuli on upper surface of lesions ($\times 380$); D, a, and E, a, colored conidia. Photographs by J. F. Brewer. F, line drawing of acervuli of this fungus (after Briosi e Cavara, *I funghi parassiti delle piante coltivate od utili*. Fasc. 6, No. 139).

Plate 33. *Hadrotrichum Populi* forma *Arbuti* on *Arbutus Unedo*. A, Showing upper leaf surface (from Briosi and Cavara, I funghi parassiti delle piante coltivate od utili. Fasc. 14, No. 349 (type); B, *Illosporium mattirolianum* on *Arbutus Unedo* ($\times 1$), showing (a) upper and (b) lower leaf surfaces (from D. Saccardo, Mycotheca italica. Century 8, No. 798 (type); C-D, *Aulographum Ledi* on *Ledum groenlandicum*; C, from phanerogamic herbarium specimen labeled "Borders of Lake Leigh, North Mountain, Pa., July 19, 1897, C. F. Saunders" in United States National Herbarium, Washington, D. C. ($\times 1$); D, from cryptogamic specimen, collected at Fine, St. Lawrence Co., N. Y., Aug. 8, 1910, C. H. Peck (\times about 8); E, 3-months-old, malt-agar medium culture of *Elsinoe Ledi* from *Ledum glandulosum*, Oregon, 1931, isolated from material contributed by S. M. Zeller. F-H, fructifications of *Hadrotrichum Populi* forma *Arbuti*, from specimen shown in A ($\times 380$). Photographs by J. F. Brewer.

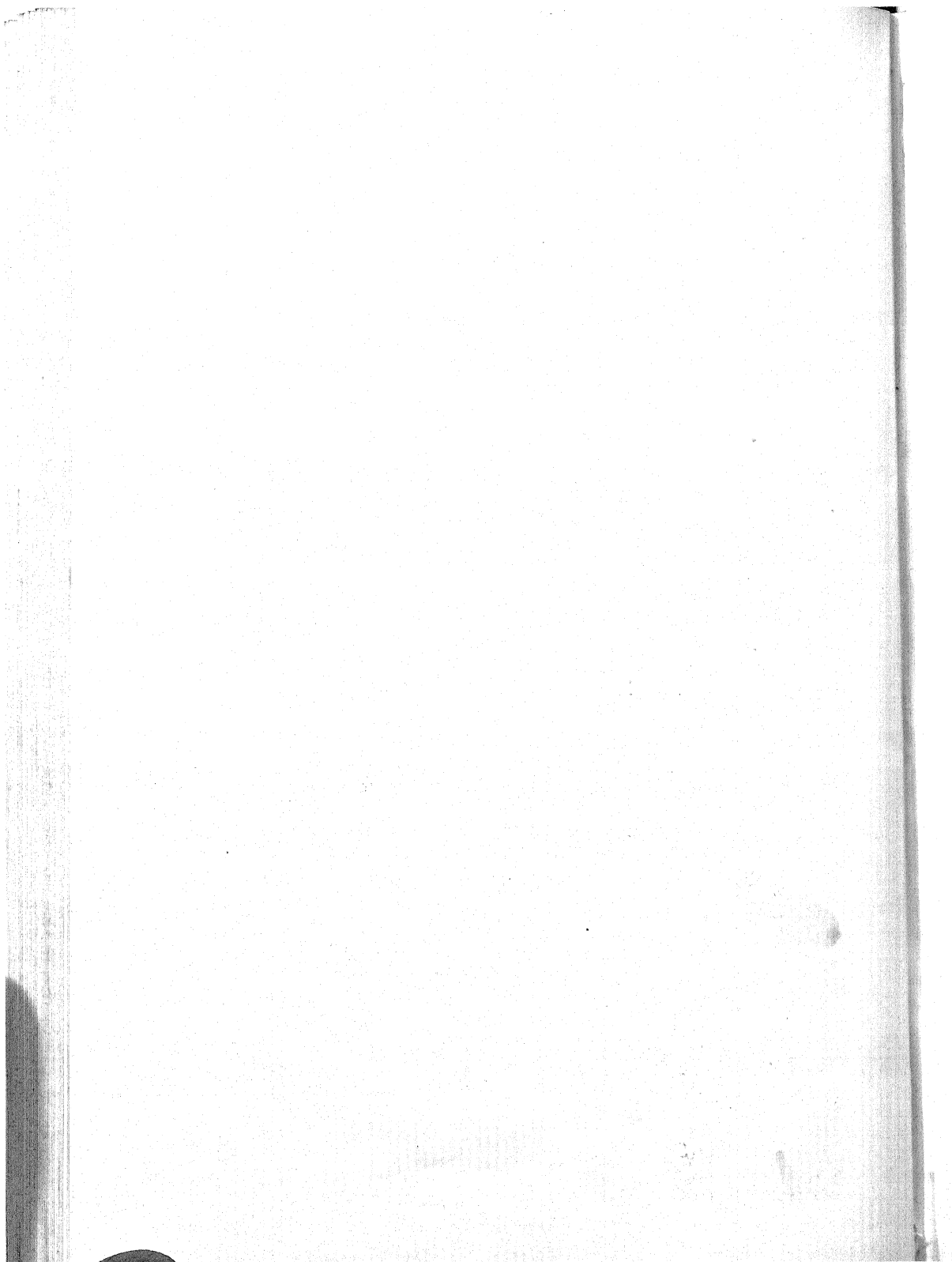


SPHACELOMA





HADROTRICHUM



NOTES ON BOLETES. II

WALTER H. SNELL

When the writer began a few years ago to collect *Boletes* for his own amusement, it was found that identification of these plants was very difficult, and in some cases almost impossible. There seemed to be no question but that some American plants had been differently named by American mycologists and were considered as distinct species, and also that many named by Peck and others have been long known in Europe. Further, it became evident that other species had been wrongly determined in terms of European species and others had been named as distinct on the basis of immature plants. In general, there is a great deal of confusion in this group, much of which confusion can be eliminated by careful and long-continued collection and study in different localities.

It is the plan to publish these notes periodically as further study can disentangle some of the confusion and as species can be accurately delimited and the synonymy straightened out.

1. *BOLETUS CLINTONIANUS* AND *BOLETUS ELBENSIS*

In last year's Notes,¹ it was pointed out that Kallenbach considers *B. Clintonianus* Peck to be the same as *B. flavus* With. ex Fries (or as he prefers to call it, *B. elegans* Fries) and that *B. elbensis* Peck is really *B. viscidus* Fries. It was stated that such changes seemed reasonable to me.

This year, further observations were made on these two species collected abundantly in North Elba near Lake Placid, N. Y., where Peck first collected them. The soundness of Kallenbach's judgment concerning both of these species—a judgment based solely upon American descriptions—was further confirmed. In addition, it was found that the spores and cystidia of the American plants were precisely as given by Kallenbach for the European species.

¹ *Mycologia* 24: 334-341. 1 fig. 1932.

It becomes necessary, therefore, to give up Peck's long used and pleasing names of these common American plants and to use the older European ones.

2. MORE ABOUT BOLETUS PORPHYROSPORUS

In 1902, Atkinson² described what he thought was a new Bolete under the name *B. umbrosus*. Murrill³ made this a synonym of *Ceratomyces communis* (Bull.) Murrill (= *B. chrysenteron* Bull. ex Fries). This was a rather strange disposition of it for the following reasons: the colors of the pileus are different; the flesh is whitish in Atkinson's plant and not yellowish as in *B. chrysenteron*, it changes to flesh-color then to brown instead of to greenish-blue and it is not red in the cracks of the pileus; the tubes are white and change to brown, instead of being yellow and changing to greenish-blue; the stipe is brownish or paler, instead of yellow above and red or streaked with red below. In other words, from the descriptions, there is no resemblance at all. Further, a casual inspection of Atkinson's plant would show that it is not *B. chrysenteron* (or *B. communis*).

As a matter of fact, Atkinson's description reads like that of Frost's *B. sordidus*, described in 1874, which the writer believes is *B. porphyrosporus* Fries. An examination of two of Atkinson's plants, kindly loaned by Professor H. M. Fitzpatrick, shows that *B. umbrosus* agrees perfectly with the writer's specimens of *B. porphyrosporus*, with the exception of a slight difference in the size of the spores (which were not described by Atkinson). In one of these plants, the spores were apparently immature, but in the second one sent by Professor Fitzpatrick, they were certainly very near to maturity if not quite mature. They were found to be similar in shape, contents and color to those of *B. porphyrosporus*. They measured $11-14 \times 4-5.5 \mu$, which measurements fall within the limits of the spores of the Friesian plant, although most of the spores of the writer's specimens measure $13-16 \times 5-6 \mu$. It may be stated here that the writer in 1932 gave the width of the spores as $5.3-6.5 \mu$. These limits should be $4-7 \mu$.

² Preliminary notes on some new species of fungi. Jour. Myc. 8: 110-119. 1902 (p. 112).

³ N. Am. Flora 9: 150. 1910.

In 1898, Peck collected near Lake Placid, N. Y., a plant which he described as *B. nebulosus*.⁴ This description is very brief, but it fits in every particular but one the descriptions of *B. porphyrosporus*. Peck describes the flesh as white and unchanging, whereas in this common European plant just named, the white flesh usually changes more or less pronouncedly to reddish or reddish-brown, and bluish-green or inky-bluish in places. In young plants, these changes may not be very conspicuous, however.

Peck did not mention—as Frost likewise did not with *B. sordidus* nor Atkinson with *B. umbrosus*—two characters that would enable one absolutely definitely to state that *B. nebulosus* is *B. porphyrosporus*, but his observations were confessedly limited. These two characters are the purplish color of spore prints and the staining of white paper bluish by the expressed sap of the pileus and tubes.

Peck's types at Albany were examined this past summer and there is no doubt that *B. nebulosus* Peck is *B. porphyrosporus* Fries. Peck's dried specimens resemble in every way, macroscopically and microscopically, those from my own collections. The peculiar porphyry-red walls of the spores is still conspicuous in spores from Peck's plants and the cystidia check absolutely.

Murrill⁵ made the following statement with regard to *B. nebulosus* as a doubtful species: "It has points in common with *C. sordidus* and *Tylopilus felleus*." It is difficult to see the resemblance to *B.* (or *Tylopilus*) *felleus*, but it probably is the same as *B. sordidus*.

Murrill also said in the same place with regard to *B. mutabilis* Morgan (not Batsch) that Peck's New York plants of this name are either *B. sordidus* or *B. felleus*. It may be true that Peck's plants are misnamed, but it is hardly possible that *B. mutabilis* is *B. sordidus*, because of the prompt changing to blue of the flesh and tubes, and the yellow color of the stipe without and within.

The writer has already suggested that *B. sordidus* Frost is the same as *B. porphyrosporus* Fries. It would therefore appear that

⁴ Ann. Rep. N. Y. State Museum 51: 292. 1898.

⁵ N. Am. Flora 9: 151. 1910.

this species, collected under these different names, though not of common occurrence, is quite widely distributed in the north-eastern states.

It may be of interest to add that this species was collected this summer near Lake Placid, N. Y., where Peck obtained his *B. nebulosus*.

3. SPECIES OF DISPUTED AUTONOMY

a. Boletus brevipes

B. brevipes Peck has been considered by many as merely a short-stemmed, late-season form of *B. granulatus*. It certainly looks at times like this latter species, with short stipe and without glandular dots. It also at times looks like one of the forms of *B. luteus* (except for length of stipe, lacks of dots and annulus) when it has the glutinous, dark-chestnut or chocolate brown pileus. *B. brevipes* can, however, hardly be a morphological and seasonal variant of these other species when it occurs along with them in the early fall, as the writer has repeatedly found it, particularly in October, 1932. I consider it as a valid species.

b. Boletus glabellus

B. glabellus Peck was made a synonym of *B. miniato-olivaceus* Frost by Murrill. Peck distinguished the former by the lack of red colors of the pileus and especially its smoky tinge, the paler flesh and more pallid stipe with a red zone or line at the apex. I would add also the less extensive and slower turning of the flesh to blue when cut or broken. My collections of plants that correspond precisely with Peck's description incline me to accept it as an autonomous species.

c. Boletus vermiculosus

This plant was considered by Murrill (loc. cit., p. 151) to be the same as *B. luridus*. Atkinson accepted it as a distinct species⁶ and I have likewise found the plant exactly corresponding to Peck's description.

⁶ Mushrooms—Edible, Poisonous, etc. 1900 (p. 177).

4. SPECIES OF DOUBTED OCCURRENCE IN THE UNITED STATES

a. Boletus badius

Boletus badius Fries has been reported in this country by several collectors, but it was not recognized by Murrill.

There is no doubt of its occurrence here, because I have found it many times in the Adirondacks near Minerva and Newcomb, growing under pines and in mixed coniferous stands bordering tamarack swamps. To me, it is readily distinguished by its tubes at first pale lemon-yellow or pale greenish-yellow, and by its pileus being at first quite viscid and later very finely tomentose. To the uninitiated, it may resemble *B. spadiceus*. The two differ in the following respects:

	<i>B. badius</i>	<i>B. spadiceus</i>
Stature	Somewhat slender	More stocky and compact
Surface of pileus	Viscid at first, then very finely tomentose	Dry, pruinose-tomentose to rough-tomentose
Tubes	Pale yellow, becoming greenish-blue where wounded, not at all decurrent; mouths not large (in American plants at least)	Golden yellow, becoming bluish where wounded, but not greenish, decurrent by a tooth; mouths large
Stipe	Streaked	Striate, occasionally reticulate, reddish within toward base

Burt was uncertain whether the form illustrated in *Icones Farlowianae* (p. 82, *pl.* 76) is *B. badius* or *B. dichrous* Ellis. Murrill made out the latter to be the same as *B. bicolor* (*loc. cit.*, p. 147), but it is difficult to understand this change. It is certainly more like *B. badius*. It would seem that the ends of justice as well as of convenience would best be served if the name *B. dichrous* were dropped and made a synonym of *B. badius*. The two have supposedly been distinguished by the following characters for *B. dichrous*:—changing of the flesh to greenish-blue, straw-colored tubes, squamulose coat and yellow apex of stipe, spores 17–18 μ long.

These characters are all occasionally found in *B. badius*. It so happens that the forms of this latter species found by the writer with yellow-topped stipes have had spores 9–12 μ long and the forms with spores 12–17 μ long have had stipes at best only light-colored at the top and usually concolorous with the re-

mainder of the stipe. I think *B. dichrous* is the same as *B. badius*.

b. Boletus spadiceus

Boletus spadiceus Fries (*B. ferrugineus* Schaeff. of European mycologists) was reported for this country only by Frost. It was not seen by Peck, who says that specimens received from Frost do not in his opinion belong to it and that its occurrence in this country is doubtful. Murrill did not recognize the species as occurring in this country.

There is a great deal of confusion among European workers regarding this species. Everyone agrees that it is very close to the very common *B. subtomentosus* L. ex Fries, and many say that it might well be considered a variety of it. Most of these writers then point out distinguishing characters, but these latter vary with the individuals. There is absolute disagreement in many important particulars. For example, most writers agree that *B. spadiceus* has purplish tints on the pileus, but some state that there is some red occasionally in *B. subtomentosus*. Bresadola says that the tube mouths of *B. spadiceus* are large, subrotund to angular; Gilbert that they are very large; Peck, Chauvin and Legué that they are minute and rotund. Bresadola says they become greenish-yellow, the French writers that they are never greenish. Most of the French workers agree with Bresadola that the stipe is fusiformly reticulate, while that of *B. subtomentosus* is costate-sulcate, but Murrill states that the stipe of this latter species is even, or wholly or partially reticulate. There is likewise disagreement as to the guttulation of the spores.

In spite of this profound disagreement as to these characters, there do appear to be certain differences which may distinguish the two species. *B. spadiceus* has the following characters:—surface of pileus purplish brown; flesh of pileus more or less dull reddish, and turning bluish, especially near the tubes; more broadly adnate attachment of the tubes, with a tendency towards the decurrent, and turning bluish occasionally; stipe more or less fusiform at the base, thicker than 1.5 cm., fusiformly reticulate, its flesh turning reddish towards the base; odor of flesh definitely fungous. On the other hand, in *B. subtomentosus*, the surface is usually brownish-olivaceous instead of purplish; the flesh and

tubes turn bluish only slightly if at all; the tubes are sinuately and narrowly adnate, and not decurrent; the stipe is attenuated at the base, but not fusiform, is less than 1.5 cm. thick, with costate-sulcate markings, and its flesh does not turn reddish within; and its odor is inconspicuous.

Murrill (loc. cit.) believes that all forms, whether with even or ribbed stipe of *B. subtomentosus*, or with somewhat reticulate stipe of *B. spadiceus*, or even the coarsely reticulate stipe from apex to base of *B. illudens*, should be placed in one species, *B. subtomentosus*.

There is no doubt in my mind, however, of the validity of *B. spadiceus*, when it is once understood. It is easily distinguished from *B. subtomentosus* in all stages of development. I find it not uncommon in the Adirondacks up to early August, but not after that. Dr. George L. Church, however, brought in a specimen from the Arnold Arboretum near Boston on October 6th of this year.

c. Boletus erythropus

The status of *B. erythropus* and *B. luridus* presents an interminable and at times an apparently insoluble tangle. The European writers almost generally agree that there are two different species to be called by these names, but they differ as to characters and details. *B. luridus* is one of the three European species with reticulate stipe, having a dark colored pileus as against the pale-colored *B. Satanus* (greenish tinged) and *B. rhodoxanthus* of Kallenbach (pinkish tinged). The other two somewhat similar species, *B. erythropus* and *B. miniatorporus* (the latter of which apparently does not occur in this country) have non-reticulate stipes. These distinctions are readily discernible according to Kallenbach and such would seem to be the case, but as between *B. luridus* and *B. erythropus*, the distinctions are complicated by the occasional lack of distinct reticulation of the stipe in *B. luridus*.

This latter fact adds to the difficulties of determining the forms found in this country, especially as *B. luridus* here rarely has a plainly and distinctly reticulated stipe. Furthermore, it often has tubes the mouths of which show little or no red coloration. This past summer I found a colony of forms in all stages of

development, in which the young plants had tubes without red mouths but decidedly reticulate stipes, and the older plants had mouths with or without the bright red color and stipes without a sign of reticulation except a patch on one stipe that showed faint signs of it. In view of these characters and the general cycle of development, the importance of which latter is so strongly emphasized by Kallenbach, these plants were apparently *B. luridus*.

I have found plants that appear to be readily determinable as *B. erythropus*, if care is taken to follow the development of the plants and the succession of color changes as given by Kallenbach. When mature plants have the typically dark carmine or blood-red pileus and the surface of the stipe that one learns to be distinctive, in addition to the lack of reticulation, determination is not so difficult (cf. plate 85 of *Icones Farlow*). When, however, this dark pileus is lacking, I have found the following characters to be distinctive:—the faded ochraceous or brownish pileus tinged reddish; the faded, dingy-olivaceous or brownish tube mouths; the non-reticulate stipe which is, for the most part, yellow in color. I have also found that the absence of reticulation on the stipes of very young plants is of definite diagnostic value. I have collected such forms in the Adirondacks and in Vermont, which I cannot but call *B. erythropus*.

Kallenbach⁷ maintains that Fries confused these forms and that *B. purpureus* of Fries is a composite species which includes the true *B. erythropus*. He has solved the problem to his own satisfaction by discarding *B. purpureus* and splitting this into the *B. erythropus* of Persoon and *B. rhodoxanthus* Kallenbach. The French mycologists cannot agree with this procedure, but I have found that Kallenbach's arrangement is workable and brings a reasonable amount of order out of what was decidedly chaos.

5. SPECIES OF SUSPECTED SYNONYMY

a. Boletinus grisellus

As pointed out in last year's Notes (loc. cit.), Kallenbach has done a distinct service by bringing together a number of different

⁷ Die Pilze Mitteleuropas. Band I. Die Röhrlinge (Boletaceae). Leipzig, p. 23.

laricophilous boletes, both American and European, under the name *B. viscidus* Fries. One of the plants thus included, on the basis of published description alone, was *Boletinus grisellus* Peck. This was first collected at Natick, Mass., and there are also at Albany collections from New York State. The writer was inclined to agree with Kallenbach on the basis of Peck's description, even though Peck placed the plant in the genus *Boletinus* instead of *Boletus*.

An examination of the plants at Albany, however, shows that *Boletinus grisellus* is quite different from Peck's *B. elbensis* (or *B. viscidus* Fries). In the first place, it is a true *Boletinus*, with the radiately arranged pores and compound tubes, separated by distinct and prominent long veins. It is not at all annulate as is *B. viscidus*, the pores are much larger (when dry at least) than those of *B. viscidus*, the surface of the pileus looks entirely different, and the tubes are very deeply decurrent. Peck said the tubes were slightly decurrent, but the tubes descend so far down the stems of the dried plants in most cases that it hardly seems as if they could be only slightly decurrent in living plants, even when plenty of allowance is made for the shrinkage due to drying.

b. Boletinus spectabilis and *B. pictus*

Kallenbach, likewise on the basis of descriptions, wondered (loc. cit., p. 75) if these two species were not really the same as *Boletus tridentinus* Bres., in spite of the stated difference in genus. No one who knows the American plants in the field could possibly agree to this synonymy. The two American plants are not only true *Boletinus* forms, but they are entirely distinct from each other, and from *Boletus tridentinus*. They differ in color, in spores and many other characters.

6. *BOLETUS ANANAS*, *B. ISABELLINUS*, AND *B. SUBALBELLUS*

Boletus Ananas was described by M. A. Curtis from South Carolina in 1848. Peck described *B. isabellinus* from specimens collected at Ocean Springs, Miss., in 1897, and Murrill described from the same place in 1910, *Gyroporus subalbellus*. The genus *Gyroporus* is characterized in Murrill's scheme (following Quélet) by hollow stipe and hyaline spores, about which we shall speak later.

Here we have three plants the descriptions of which read much alike, with two collected from the same locality. These two, *B. isabellinus* and *B.* (or *Gyroporus*) *subalbellus*, resemble each other more than they resemble *B. Ananas*, yet Murrill made *B. isabellinus* a synonym of *B. Ananas* (in the genus *Boletellus*). Peck partially concurred in this arrangement, saying the two were apparently the same, but he pointed out what he thought were important differences (letter to Murrill in the New York Botanical Garden).

Examination of these plants in The New York Botanical Garden (including the type of Murrill's species and the co-type of Peck's species) showed that they do resemble each other somewhat. On the other hand, even though the specimens of *B. isabellinus* and *B. subalbellus* are obviously immature, the appressed fibrillose scales of these species are entirely different from the prominent pyramidal scales of *B. Ananas*.

It is a question whether or not the spores of these plants will help much in the determination of their identities, even though the spores obtainable are quite different. The spores of all species of boletes examined by the writer are elliptical and hyaline in the early stages of their development. Those of the specimens of *B. isabellinus* available are pyriform, elliptic, or elongate-ovoid and more or less hyaline, measuring $5-10.5 \times 3.5-4.5 \mu$ (mostly $7-9 \times 3.5-4 \mu$). Those of *B. subalbellus* are oblong-elliptic, not quite hyaline it seems to me, and measure $5.5-10 \times 3.5-5 \mu$ (mostly $8-4 \mu$). There is thus little resemblance between the spores of these two sets of specimens, as they are now obtainable, but I think they are all immature. There is no resemblance at all between the spores of *B. isabellinus* and *B. Ananas*, for the spores of this latter plant are double the size of those of the former (as now available), they are uniformly elliptic-ovoid, and are dark brown and longitudinally striate.

It may perhaps be that Murrill ignored the appearance of the spores of *B. isabellinus*, in view of the facts that the plants were doubtless immature and the spores probably so. He may have operated upon the hypothesis that these more or less elliptical spores of *B. isabellinus* in the plants available to him would become at maturity similar to those of *B. Ananas*, and at the same

time he would have had to ignore the dissimilarity in the scales of the two sets of specimens.

On the other hand, by the same token, he must have ignored the present immature condition of the more or less oblong, hyaline spores of *B. subalbellus*, because he placed this species in his new genus *Gyroporus*, characterized by spores elliptical in form and whitish or citrine in mass. It appears to me as if these spores would be olivaceous in mass at maturity, if they would not be olivaceous in mass in their present condition.

Under any conditions, however, with the specimens at present available, there seems to be no justification for considering *B. isabellinus* the same as *B. Ananas*. It seems to me more likely that *B. subalbellus* is the same as *B. isabellinus* (both from the same locality). Before any satisfactory disposition can be made of these two species, however, mature fruit bodies and spore prints must be made available for study.

7. BOLETUS ALBUS = B. PLACIDUS

Peck named *Boletus albus* in 1872 and stated that it differed from *B. collinitus* Shaeff. (by which he probably meant *B. granulatus*) by its white pileus, larger and different colored tubes, etc. Later he mentioned an occasional peculiar fetid odor. Murrill made this species a synonym of *B. granulatus*.⁸ Michael-Schulz⁹ suggests that it is possibly the same as *B. placidus* Bon. and Bresadola¹⁰ says that it does not seem to be different. Other European workers agree with Bresadola (see Konrad¹¹).

B. placidus is placed by many workers in the genus *Gyrodon* (cf. Bresadola, loc. cit.), which is characterized by short tubes and sinuate or gyrose-plicate tube-mouths.

In the Adirondacks, I have several times collected an ivory-white-capped bolete which according to Peck's treatment of the group would have to be *B. albus* and which seemed to be well illustrated by colored plates of *B. placidus*. The stipes were often long, to make the fruit bodies taller than those commonly

⁸ N. Am. Flora 9: 153. 1910.

⁹ Führer für Pilzfreunde. 1927 (pl. 273).

¹⁰ Iconographia Mycologica. Milan. 1931 (p. 944).

¹¹ Konrad, M. P. Notes critiques sur quelques champignons du Jura. Bull. Trim. Soc. Myc. Fr. 43: 199-204. 1927.

identified as *B. granulatus*. The tubes of these specimens were always short, and the glandular dots on the stipe were large, often confluent and occasionally connecting to form a coarse network, such as is a common feature of illustrations of *B. placidus*. The spores measured $8-10 \times 3-3.5 \mu$, instead of $6-8 \times 2.5-3 \mu$ for *B. granulatus*. Also the sporophores were cespitose.

During the past two summers I several times have found young specimens with the ivory-white cap, growing in clusters under white pine. Instead of collecting them at once, I allowed them to grow and observed them daily. The surface gradually changed from ivory-white to the light-brown, gluten-streaked combination so characteristic of *B. granulatus*, but the plants were taller and in every other respect agreed with *B. placidus*, if one excepted any mention of sinuate or gyrose tubes. Konrad (loc. cit., p. 200) says that Saccardo manifestly erred when he put the latter species and other supposedly distinct species in the genus *Gyrodon*.

Therefore, if the European *placidus* is a true *Boletus* and not a *Gyrodon*, there is no question but what our *B. albus* is the same as the European *B. placidus* and I shall henceforth so consider it.

It is interesting to note that Konrad (loc. cit., p. 202) quotes Dr. René Maire as wondering why *B. placidus* (or *B. fusipes* Fries) has not been reported from America in white pine forests and as concluding that the reason is that Americans have called it *B. albus* instead. This species is found in central Europe only under or near *Pinus strobus* and *Pinus cembra*, and Konrad (loc. cit., p. 200) states that *B. placidus* is native to, and imported from, North America.

According to Konrad, *B. Boudieri* Quélet is the same as *B. Bellini* Inzenga, a sub-species of *B. placidus* Bon., which grows under *P. halepensis* in the Mediterranean region.

BROWN UNIVERSITY
PROVIDENCE, RHODE ISLAND.

NOTES AND BRIEF ARTICLES

SUMMER FORAY OF THE MYCOLOGICAL SOCIETY OF AMERICA

Present plans contemplate holding the summer foray in the Southern Appalachians from August thirty-first to September second. At the invitation of Dr. E. E. Reinke of Vanderbilt University, Director of the Highlands Biological Laboratory at Highlands, North Carolina, the laboratory will be the headquarters. It is urged that members of the society arrange their summer plans so as to permit attendance at this meeting. Further details will be published in the next issue of MYCOLOGIA.

REVIEWS

Three interesting and important publications upon the Boletaceae have appeared in the last few years.

The first is volume I of "Die Pilze Mitteleuropas" (Leipzig, 1926-1930, incomplete) published jointly by Die Deutsche Gesellschaft für Pilzkunde, Die Deutsche Botanische Gesellschaft and Der Deutsche Lehrerverein für Naturkunde. This publication is appearing in numbers of four to twelve pages each, quarto size, and two or three colored plates and one or two plates of reproductions of photographs and line drawings each—both excellent. The colored plates, made from water color drawings, include fruit bodies in all stages and in all variations of form and color. The half-tone reproductions are merely supplementary to these, but the line drawings represent the microscopic details which have heretofore been so sadly neglected. It is intended that each volume of the series shall be made up of about twenty numbers.

Volume I, of which eleven numbers have already appeared, is entitled "Die Röhrlinge (Boletaceae)" and has been prepared by Franz Kallenbach. Nineteen species have thus far been treated in this volume.

This work is remarkable for the completeness of treatment of the species. Each species is discussed under the following head-

ings: synonymy, original diagnosis, complete description (including chemical reactions of the flesh to various reagents), value (edibility), forms with which it may be confused, microscopic details, habitat (with geological considerations), distribution, history (with critical remarks), literature, and short description or diagnosis.

In addition to the extreme completeness of treatment, including the microscopic details and chemical reactions, this treatise is valuable in other ways. For one thing, the author has emphasized the necessity of considering the cycle of development of each plant and the succession of color changes. He has made good use of this principle in the delimiting of some species and the combining of others. Also, he has pointed out the danger of following Fries too closely, for he thinks that Fries made some mistakes and misunderstood certain forms—which misunderstanding has resulted in considerable confusion in the proper interpretation of several species.

Some of the French mycologists cannot agree with Kallenbach's adjudication of some of the species and their synonymy, but he has done much to increase our taxonomic knowledge of these plants and his results appear to be workable.

The second publication is "Les Bolets," by Sartory and Maire (Nancy). The scope of the work is given on the title page—"Monographie du Genre Boletus, Dill." The introduction discusses the general characters of the Boletes and the different classifications, and gives a historical synopsis. The main body of the work is entitled "Étude des Espèces du Genre Boletus" and this title explains its scope. It is a compendium of all the species of Boletes that have been described. For each species there is given the synonymy, literature, illustrations and models known, and the diagnoses of the original authors and many subsequent students, along with comments of the latter in many cases. No comments are added by the authors of the treatise.

These authors place all the species under one genus—*Boletus*—instead of the three commonly accepted, and thus avoid one source of disagreement among students of the group. The species are likewise not classified according to any scheme, but are taken up alphabetically.

There are some errors, typographical or otherwise, as would be expected from the handling of so many names, dates, numbers and diagnoses. There is a lack of complete consistency in treatment of certain of the species that is sometimes puzzling. The synonymy in certain cases is somewhat unfortunate, especially with regard to the American species. This, however, could hardly be avoided, because the errors arise from the lamentable condition of American literature upon the subject.

In spite of the errors, relatively few in number, the work is a very useful one as a source-book and places at the disposal of students of the group a mass of convenient information.

The third publication is "Les Bolets" by E.-J. Gilbert (Paris, 1931). It is a treatment of the morphology and taxonomy of the Boletes. It discusses the relation of these plants to the Agarics, especially to the genera *Gomphidius* and *Paxillus*, the development of the carpophores, the taxonomic history, and mainly the genera and their generic affinities and the species and their specific affinities.

The main thesis is the development of a new classification into: suborders on the basis of ornamentation of the spore membrane; families on the basis of the nature of the hymenophore tissue, gross morphology and habit of living; genera on the basis of morphological development (angiocarpous or gymnocarpous) and morphology of the spores. Thus there result the following: suborders, Boletineae and Strobilomycetinae; families, Paxillaceae, Boletaceae, Leucosporelleae and Gyreae of the former, and Strobilomycetaceae of the latter; and thirteen genera, including several suggested by Quélet and Karsten, two by Murrill (all somewhat modified) and one new one (*Porphyrellus*) as well as the three usually accepted, along with *Paxillus* and *Phylloporus* usually placed in the Agaricaceae.

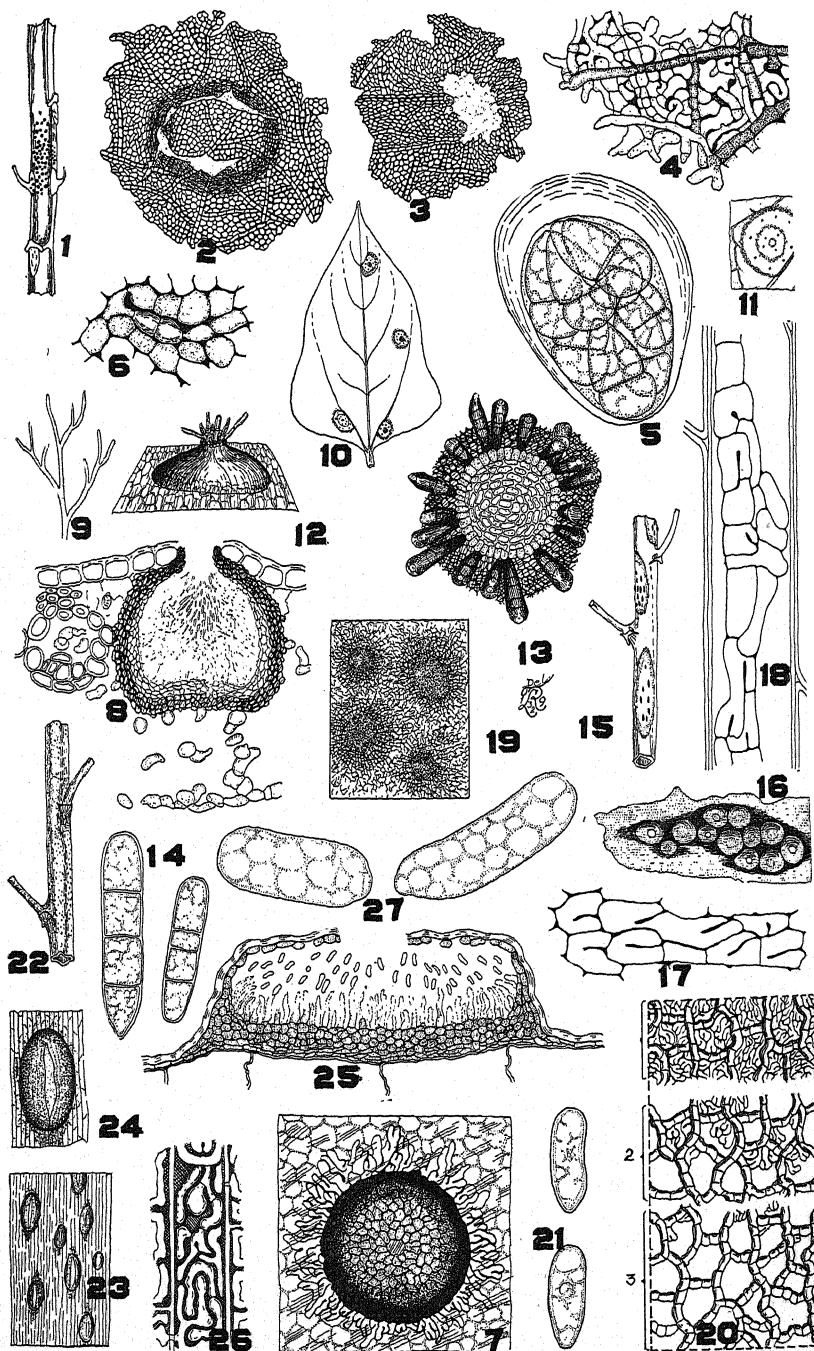
This classification, then, is along the line of the modern tendency to split the old Friesian genera and it may be said that this attempt as applied to this group, has more to recommend it in the way of morphological grounds, logic and consistency than any that have preceded it. Whether or not the two Agaricaceous genera should be included in the Boletaceae may be questioned by many, and other features may raise qualms of surprise or violent

disagreement in the minds of mycologists. On the other hand, if the group is to be split up, most of the groupings seem to be natural. For example, the genus *Ixocomus* Quélet, including species with viscid or glutinous pileus and with ellipsoid spores, is a natural group—the tribe Viscipelles of the Friesian system.

It is probable that this new classification will be graciously received by the “splitter” school of “revisionists” in modern mycology, but will be just as roundly rejected by the more conservative element.

WALTER H. SNELL

BROWN UNIVERSITY,
PROVIDENCE, RHODE ISLAND



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NOTES ON THE PARASITIC FUNGI OF ILLINOIS

LEO R. TEHON

(WITH PLATE 34)

In this much delayed supplement to the four papers that have preceded it ¹ a number of novelties are presented, both in genera and in species, some comparisons are made and keys constructed for special groups of species, and notes on extended distributions and host ranges are given. These are based on material in the Mycological Collection of the Illinois State Natural History Survey, and type and other specimens are designated by their accession numbers in that collection. The collections were made by Mr. G. L. Stout, formerly Field Botanist of the Illinois State Natural History Survey, and by the writer.

The nomenclature of the hosts is that given in Gray's New Manual of Botany, Seventh Edition, except for cultivated plants, for which Bailey's Manual of Cultivated Plants is followed. Type specimens will be found duplicated, as far as our material will permit, in the herbarium of The New York Botanical Garden. Further distribution is not planned, but mycologists are assured that a desire to examine material will receive most cordial consideration.

MICROTHYRIELLA RUBI Petrak.

Though they frequently pass unnoticed, "fly speck" fungi are relatively common on members of the Rosaceae in temperate

¹ See Mycologia 16: 135-142, for the first of the series; *ibid.* 17: 240-249, for "Notes—II"; *ibid.* 19: 110-129, for "Notes—III"; and *ibid.* 21: 180-196, for "Notes—IV."

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regions. In the main they are little understood, since as usually seen they consist only of a thallus and do not furnish either ascigenous or conidial reproductive bodies.

A chance collection on a wild species of *Rubus*, *R. argutus* Link, made near Pana, Christian County, Ill., July 1, 1926 (Acc. No. 22, 447), furnished an ascigerous stage and suggests a possible relationship for the commonly non-sporulating forms found on other members of the rose family.

The "fly speck" on *Rubus*, as exemplified by our material, is tiny—rarely more than $\frac{1}{3}$ mm. in diameter—shining black, and circular in outline to the naked eye. The thyriothecia are arranged in groups without special relation to one another on one side of the stem and are placed without relation to buds, leaf-scars, leaves or thorns, as shown in plate 34, figure 1. Microscopically, however, they are found to be irregular in outline, with decidedly erose margins, 150–375 μ in diameter, and by transmitted light brown and relatively translucent. In structure, they are pseudoparenchymatic and consist of a somewhat arched, shield-like plate of cells which covers the ascogenous region. A true radiate structure appears not to be present, but the plate of mycelium is traversed at irregular intervals, and in various directions, by lines, or rows of cells, possibly hyphae, that are larger and more heavily walled than the bulk of the cells making up the plate. This characteristic is shown in plate 34, figures 2 and 3. These strands form a sort of framework, as if for the support of the roof of the spore-bearing structure, and the interstices between them are completely filled with cells and branches irregularly proliferated from them. Toward the margins of the plates, the rafter strands become less clearly distinguished, merging as shown in plate 34, figure 4 into the cells which form the edge of the plate. The structure here indicates a lack of superficial mycelium extending beyond the fruiting structure, and there is here some indication that the mycelium is "radiate" in structure.

Upon attaining maturity, a central portion of the thyriothecial plate, somewhat more elevated than the rest, is separated by an irregular crack, as shown in plate 34, figure 2, and reveals, when it falls away, the hymenium below. In this there are a considerable number of nearly spherical to oval, apically thickened asci.

plate 34, figure 5, which contain eight 2-celled spores. The septum in the spore is placed somewhat nearer one end, thus giving to the spore the aspect commonly expected from species of *Mycosphaerella*.

The "fly specks" appear to be derived directly from germinating ascospores, as shown in plate 34, figure 6. This condition was observed but rarely, and then only in connection with very poorly developed thalli. In mature thyriothecia, the spore cannot be discerned.

If the concepts expressed by Theissen and Sydow² are followed, the *Rubus* "fly speck" is referable to the genus *Microthyriella* von Höhnelt and appears in all respects identifiable as *M. Rubi* Petrak, though it appears to have been commonly reported (*vide* Seymour's "Host Index") as *Leptothyrium pomi*.

During our study of this fungus recourse was had to various exsiccati, among them No. 563 in C. F. Baker's "Fungi Malayana." This apparently is part of the type material of *Microthyriella philippinensis* Sydow. But we found it not referable to the genus *Microthyriella*, as it had scolecoform, multiseptate, faintly olivaceous spores and a thyriothecial structure too compact and indistinct to be recognized as that usually seen in the genus. While it is probable that in the collection originally named by Sydow a bonafide *Microthyriella* was seen, it seems necessary to designate the additional material as

***Phragmothyriella Sydowii* sp. nov.**

Thyriothecia strictly epiphyllous, scattered, not in spots, superficial, circular, ostiolate, carbonaceous except a narrow zone at the edge which is olive green, 675–900 μ in diameter, with a compactly interwoven, very fine, hyaline mycelium extending on all sides for an additional 100–300 μ ; ostiole circular, centrally placed, 10–15 μ in diameter, perhaps false; paraphyses none; asci broadly oval to elongate, short stalked, 8-spored, 105 \times 45 to 150 \times 50 μ ; ascospores long, slender, dilute olivaceous, 8- to 11-septate, constricted at the septa, acute at the tips, 100–140 \times 10–16 μ .

Thyriotheciis in pagina supra solim non in maculis sitis sparsis superficialibus rotundatis carbonaceis sed cum zona angusta olivacea-viridi ad margines ostiolatis 675–900 μ diametris mycelio hyalino tenuissimo compaginato

² Ann. Myc. 15: 389–491. 1917.

100–300 μ latitudine cinctis, ostioli rotundatis in centro sitis 10–15 μ diametris, paraphysibus nullis, ascis late ovalibus vel elongatis, 105–150 \times 45–50 μ , sporidiis longis tenuibus dilutis-olivaceis octies ad undecies septatis ad septa angustioribus ad apices acutis 100–140 \times 10–16 μ .

Type: In No. 563, C. F. Baker's "Fungi Malayana," on *Lepisanthes schizolepis*, Los Banos, Province Laguna, Luzon, Philippines, July, 1914, and accompanying slide in the herbarium of the University of Illinois.

Phyllosticta smilacis Ellis & Martin.

A specimen referable to this name was taken on *Smilax rotundifolia* L. July 28, 1926 (Acc. No. 20, 945) near Sparta, Randolph County, Ill. The pycnidia are 60–70 μ in diameter and the spores 10–12 \times 6.5 μ . The pycnidia do not, however, have the definitely formed ostiole characteristic of the species, but appear to open through the breaking away irregularly of a small number of cells near the summit. The context of the pycnidial wall is entirely pseudoparenchymatic, and in this resembles the examples of the species commonly seen. But the specimen is particularly remarkable in that, at the edges of the pycnidia—these are, by the way, spherical when seen in section—where contact is made with the epidermis of the leaf, there occurs an outgrowth of mycelial strands that resemble in form and compactness the so-called "radiate" mycelium characteristic of many of the Hemisphaeriales. The aspect of the pycnidium and its fringe is shown in plate 34, figure 7.

It is, perhaps, unfortunate to have to make report of this peculiarity. A number of names^{3,4} have been given to imperfect forms on species of *Smilax*, and the impression has become prevalent, as a result of Dearness' study, that there is probably only a single polymorphic species involved. In material which we have examined we have not previously seen radiate mycelium and so are inclined to look upon the present material as tending to indicate a lesser relationship among the various forms than might be supposed, though we do not venture at present to segregate our material to the extent that it appears to deserve.

Phyllosticta neuroterigallicola sp. nov.

Spots apparent on both leaf surfaces, consisting of a central

³ Dearness, John, in *Mycologia* 9: 351–352. 1917.

⁴ Tehon, L. R., in *Mycologia* 19: 123. 1927.

region 5–10 mm. in diameter which centers in the leaf tumor caused by an insect, *Neuroterus* sp., and definitely bordered outwardly by a black line which is very fine above but diffused to 1 mm. or more of width below and of a peripheral region of indefinite extent that is chestnut brown both above and below, not limited by the veins and with an entire diameter of 2–3 cm.; pycnidia abundant within the central area, erumpent through the upper surface only, spherical, dark brown to completely carbonaceous, 90–180 μ in diameter; ostiole slightly papilliform, usually more fully carbonized than the pycnidial wall, its opening round, 10–15 μ in diameter; spores hyaline, oval, $8.5\text{--}11 \times 6.5\text{--}8 \mu$; mycelium brown, much branched, distantly septate, $3.5\text{--}5 \mu$ in diameter.

Maculis amphigenis 2–3 cm. diametris in tumoribus Neuroterorum sitis supra ad marginem linea tenuissima atronitida finitis intus castaneis, pycnidiis abundantibus in centro macularum sphaericis brunneis membranaceis vel carbonaceis 90–180 μ diametris per paginam superam solim erumpentibus, ostiolis paulo papilliformibus carbonaceis rotundatis 10–15 μ diametris, sporidiis hyalinis ovalibus $8.5\text{--}11 \times 6.5\text{--}8 \mu$, mycelio brunneo ramoso remote septato $3.5\text{--}5 \mu$ lato.

On leaves of *Quercus imbricaria* Michx., Dongola, Union County, Ill., Aug. 11, 1927. Acc. No. 22, 830 (type).

In naming this as a new species it has been kept in mind, of course, that the oaks are generally subject to insect attack and that they commonly produce galls and intumescences of various kinds as a result of the attack. A number of imperfect fungi have been discovered in connection with these pathological manifestations. We have made direct comparisons with such fungi as *Botryodiplodia gallae* (Schw.) Petrak & Sydow (for which no less than 14 descriptions or synonyms exist), *Diplodinula gallae* (Ellis & Ev.) Tassi, and *Diplodinula quercina* (Peck) Tassi; but it has been impossible to allign our material with any of the samples or descriptions available to us.

Among the species of *Phyllosticta* known in America, those on oaks appear, as indicated by specimens or descriptions, to be separable on the following basis.

Associated with galls or intumescences of insect origin.

Spores $\frac{1}{3}$ as wide as long, $3 \times 10\text{--}12 \mu$.

P. tumoricola.

Spores at least $\frac{1}{2}$ as wide as long.

Spores small, $1\text{--}1.5 \times 2\text{--}3 \mu$.

P. vesicatoria.

Spores large, $6.5\text{--}8 \times 8\text{--}11 \mu$.

P. neuroterigallicola.

Forming characteristic spots and not associated with galls or intumescences.

Spores very large, 18–22 μ long.

P. phomiformis.

Spores not over 15 μ long.

Spots marginal, often extensive.

Pycnidia up to 150 μ in diameter.

P. ludoviciana.

Pycnidia 150–200 μ in diameter.

P. agrifolia.

Spots not marginal, usually definitely limited.

Spores 10 μ or more long.

P. Wislizeni.

Spores less than 10 μ long.

Pycnidia large, up to 200 μ in diameter.

P. Quercus.

Pycnidia smaller, up to 150 μ in diameter.

Pycnidia erumpent above only.

Spots white or silvery.

Pycnidia scattered over the spot.

P. Quercus-ilicis.

Pycnidia collected in center of spot.

P. Quercus-rubrae.

Spots brown.

Lower surface of spot blistered.

P. virens.

Lower surface not blistered.

Spores globose, 3–5 μ in diameter.

P. quercea.

Spores ovoid.

Spore dimensions

2–2.5 \times 5–6 μ .

P. Quercus-prini.

Spore dimensions

2–3 \times 3–5 μ .

P. quercea.

Pycnidia erumpent to either leaf face.

P. livida.

Phyllosticta dispersgens sp. nov.

Spots at first small, 1–2 mm. in diameter, chocolate brown on the upper side, greenish brown on the lower, not limited in size but extending, either alone or by confluence, over much of the leaflet blade, not completely killing the host tissue but producing some discoloration; pycnidia very abundant, scattered, developed in and occupying the mesophyll, opening to either surface, when young yellowish but when mature dark brown without carbonization except in a ring about the ostiole, spherical to applanate, erumpent to the extent of half the height eventually, 80–135 μ in diameter, wall 2–3 cells thick; ostiole only slightly papilliform, the opening round, 6–10 μ wide; spores hyaline, minute, straight, rod-like, 4.5–6 \times 0.7 μ .

Maculis primitis minutis 1-2 mm. diametris in pagina supra brunneolis in pagina infera viridulis extendentibus solim vel confluyente macularum per partem maximam folii, pycnidii abundantibus sparsis in medietate folii sitis sed aut superam aut inferam paginam pertudentibus membranaceis brunneis non carbonaceis sphaericis vel deplanatis tandem erumpentibus 80-135 μ diametris, ostiolis paulo papilliformibus, rotundatis 6-10 μ diametris circulo cellarum carbonacearum circumvallatis, conidiis hyalinis minutis rectis bacillaribus $4.5-6 \times 0.7 \mu$.

On leaves of *Rubus flagellaris* Willd., in the vicinity of Belleville, St. Clair County, Ill., Aug. 9, 1927. Acc. No. 829 (type).

Because of the indefinite form and extent of the spot and the apparently non-fatal effect of the attack, this species is exceedingly interesting. It is readily distinguished from *Phyllosticta variabilis* Peck on *Rubus odoratus* L. both by the size of its spores and the kind of spot produced, from *P. Dearnessii* Sacc. on *R. triflorus* Richards by both the pycnidia and spores as well as the nature of the host reaction.

***Phyllosticta Anserinae* sp. nov.**

Folicle, spots diaphyllous, circular, 0.5-1.5 mm. in diameter, cinereous, very distinctly purple margined, not friable; pycnidia 1 to 4 per spot, membranaceous except for a small carbonaceous ring surrounding the ostiole, lying in the palisade and parenchyma and, in the type at least, opening only epiphyllously, spherical to applanate, 105-165 μ in diameter; ostiole papilliform, carbonized, the opening somewhat irregular, up to 14 μ in diameter; spores issuing in cirrhi, bacilliform, $4.5-6.5 \times 0.9-1.3 \mu$.

Maculis amphigenis rotundatis 0.5-1.5 mm. diametris cinereis non friabilibus cum marginibus purpurascenscentibus, pycnidiiis membranaceis sphaericis vel applanatis 105-165 μ diametris, in medietate folii sitis paginam superam solim pertudentibus, ostiolis papilliformibus cyclo cellarum carbonacearum circumdatis ad 14 μ diametris, sporidiis bacillaribus $4.5-6.5 \times 0.9-1.5 \mu$.

On living leaves of *Potentilla Anserina* L., Witt, Montgomery County, Ill., June 23, 1927. Acc. No. 22, 762 (type).

This species is very close to *P. potentillica* Sacc., from which it differs especially in spore shape, and to *P. fragaricola* Desm. & Rob., from which it differs particularly in having much more slender spores. With regard to spore diameter, it is intermediate between the two old species.

PHYLLOSTICTA MEIBOMIAE Seaver.

Described by Seaver⁵ from material collected by Geo. V. Nash and originally determined as *P. Desmodii* Ellis & Ev., this species

⁵ N. Am. Flora 6: 28. 1919.

has not, so far as we are aware, been recorded elsewhere than in Florida and Alabama, as was originally indicated by Seaver. The assumption might be made that this is strictly a southern form, but its occurrence further north is substantiated by a specimen taken August 11, 1927 near Dongola, Union County, Ill. (Acc. No. 22, 832), which agrees in every particular with Seaver's description. The host, as determined for us by Dr. H. S. Pepon, is *Desmodium Dillenii* Darl. The distinction made by Seaver between *P. macroguttata* Earle and *P. Meibomia* seems to be well founded and of the order required for separation of species, and this fact adds significance to our Illinois collection especially in that our material was found on the host recorded for Earle's species. As both species, so far as they have been known, were entirely southern, we may suppose that *P. Meibomia* has extended in its range northward into Illinois along with the coastal swamp forest which has followed the Mississippi, Ohio, and Cache river valleys. The locality in which our collection was taken is, at least, within the range of this extension.

PHYLLOSTICTA ANTIRRHINI Sydow.

In the vicinity of Ashley, Washington County, Ill., there was taken August 26, 1927 (Acc. No. 22, 828) a leaf spot of *Pentstemon hirsutus* (L.) Willd. bearing a *Phyllosticta*. The spots are small—0.5–3 mm. in diameter,—roughly circular in outline, snowy white, friable, and with a tendency to fall away so as to leave rather clean cut circular holes. A narrow, dark purple halo surrounds them. Numerous membranaceous pycnidia dot the white areas of the spots and open chiefly toward the upper surface. On this host, they range from 55–100 μ in diameter. Spores liberated from them are oblong, often definitely allantoid, and measure $3\text{--}4.5 \times 1.5\text{--}2.3 \mu$.

The spore size corresponds very closely with that given by Guba and Anderson⁶ for *Phyllosticta Antirrhini* when they took spores directly from the host, while the spore shape presents precisely the aspect figured by these authors.

It is exceptionally interesting that a fungus so similar in all particulars should be found native on a host belonging to the same

⁶ Phytopathology 9: 315–325. 1919.

family as does the snapdragon, and one may well believe that the fungus studied by Guba and Anderson, earlier by Stewart,⁷ and later by Smiley⁸ is actually native to this country, even though it be regarded as identical with Sydow's European species. There seems, also, to be no reason for supposing that *Phoma poolensis* Taubenh. differs from this *Phyllosticta*. The writer has not seen authentic material of Sydow's species, but according to the description the European and American forms should give rather definite differences upon closer comparison.

Phyllosticta scariolicola sp. nov.

Spots extending through the leaf but more distinct above, subcircular to distinctly angular and limited by the veinlets, 1–2 mm. in diameter, occasionally confluent, with margins well defined, raised, and purple tinted, the center becoming dark tan, very thin and translucent but not friable until dried; pycnidia scattered, few, generally 4 to 6 per spot, opening to either surface, membranaceous or ultimately becoming opaque by carbonization, subspherical to (more often) very markedly applanate, the flattening mostly basal and giving a horizontal diameter of 70–100 μ and a vertical diameter as small as 20 μ ; ostiole definitely papilliform, the opening subcircular and up to 10 μ in diameter; spores non-septate, oval but very variable, hyaline, with a green tint, $1.5\text{--}3 \times 4\text{--}6.5 \mu$.

Maculis in foliis amphigenis subcircularibus vel angulatis brunneis cum marginibus purpureis 1–2 mm. diametris, pycnidiis sparsis paucis quatuor ad sex utrique maculae membranaceis in utraque pagina perrumpentibus sphaericis vel deplanatis, 70–100 μ diametris; sporidiis continuis, ovalibus, hyalinis $1.5\text{--}3 \times 4\text{--}6.5 \mu$.

On living leaves of *Lactuca scariola* L., West Union, Clark County, Ill., June 8, 1927. Acc. No. 22, 503 (type). Also Mt. Vernon, Jefferson County, Ill., June 11, 1927. Acc. No. 22, 523.

So far as I am able to determine, this is the first report of a *Phyllosticta* on *Lactuca scariola* in America. According to Seymour's "Host Index," *L. canadensis* serves as host for *P. decidua* Ellis & Kellerm. and *P. Lactucae* Atk., the former having been reported from Wisconsin by Davis. On *L. spicata* Davis has described *P. Mulgedii*, which is thus far known only from Wisconsin. In the spot it forms and in its other characteristics

⁷ N. Y. (Geneva) Agr. Exp. Sta. Bull. 179. 1900.

⁸ Phytopathology 10: 232–248. 1920.

it is quite obviously different from the species herein named. According to Davis' notes, the form reported by him as *P. decidua* is probably identical with our Illinois material. I am not satisfied, however, to leave the Illinois material in the *decidua* group, because, first, to do so would violate the tenet of specificity of host relationship in a genus known to be, in nature, often very particular and, second, as Seaver has pointed out, the affinities indicated by "*decidua*" forms on various hosts for different ascigerous genera indicate a specific differentiation not clearly recognizable on morphological grounds alone.

***Dendrophoma Zeae* sp. nov.**

Inhabiting extensive areas on blades of arid leaves, not forming spots; pycnidia very abundant, for the most part discrete, arranged in linear series between the veins, becoming erumpent epiphyllously though developed in and occupying the mesophyll, 180–330 μ in diameter, spherical to applanate, often compressed to subspherical between veins, dark brown, membranous, composed of a pseudoparenchyma divided into a dark outer layer, the pycnidium proper, and a hyaline inner layer of variable thickness, seated in a very loose plectenchyma which replaces the host tissue; ostiole papilliform, markedly carbonized, becoming erumpent by rupturing the epidermis, its opening circular, definitely formed, 10–15 μ in diameter; spores hyaline, non-septate, rod-like to oblong or oblong-elliptical, $2\text{--}2.5 \times 8\text{--}12 \mu$; conidiophores very long and slender, 1–1.5 μ wide, racemosely branched, and with the conidia acrogenous. (PLATE 34, FIGS. 8, 9.)

Maculis nullis sed pycnidiis discretis epiphyllis sphaeroideis membranaceis 180–330 μ diametris abundantibus in areis magnis in foliis exaridis, ostiolis papilliformibus carbonaceis rotundatis 10–15 μ diametris, conidiis hyalinis continuis oblongis vel oblongis-ellipticis $2\text{--}2.5 \times 8\text{--}12 \mu$, basidiis longissimis tenuibus 1–1.5 μ latis ramosis similibus racemo cum conidiis acrogenis.

On arid leaves of *Zea Mays* L., Clay City, Clay County, Ill., Nov. 8, 1926. Communicated by G. L. Stout. Acc. No. 7742 (type).

In the same specimen is found *Macrophoma Zeae* Teh. & Dan., and both forms appear together in sectioned material. The *Dendrophoma*, in section, appears much like a *Phomopsis*, because of the two distinct layers in the pycnidial wall. The inner, hyaline layer is at times so thick that scarcely more than half the interior of the pycnidium is left for the conidiophores and spores.

Coniothyrium Fagi sp. nov.

Folicole, causing round spots 2–3 mm. in diameter, light brown above with a lighter center, cinereous beneath; pycnidia usually epiphyllous, rarely hypophyllous, carbonaceous at maturity, few, arranged so as to abut on the veins, subspherical to applanate, 100–120 μ in diameter, spore chamber 65–85 μ in diameter; ostiole definite, round, 10–14 μ wide; pycnidia lying in the pallisade and mesophyll; spores non-septate, olivaceous, oval or spherical, mostly $3.5 \times 3 \mu$. Mycelium abundant in the tissue, brown, and forming a loose plectenchyma.

Maculis in foliis irregulariter rotundatis 2–3 mm. diametris brunneolis cum centro pallidiore supra cinereis infra, pycnidiis solite paginam superam raro paginam inferiorem penetrantibus carbonaceis sphaericis vel deplanatis 100–120 μ diametris cum loculis sporarum 65–80 μ diametris; ostioliis definitis rotundatis 10–14 μ diametris, sporidiis continuus ovalibus vel sphaericis olivaceis circiter $3.5 \times 3 \mu$; mycelio abundante brunneo.

On leaves of *Fagus grandifolia* Ehrh., Alto Pass, Union County, Ill., June 13, 1927. Acc. No. 22, 555 (type). The type material is scanty, consisting of two leaves, on each of which there are four spots.

Ascochyta plantaginella sp. nov.

Folicole, spots extending through the leaf, subcircular, tan, becoming friable and falling away, 2–5 mm. in diameter, surrounded above but not below by a diffused purple border; pycnidia abundant, scattered, lying in the mesophyll but opening to either surface, yellowish or light brown, membranaceous, and somewhat carbonized about the ostiole, 90–170 μ in diameter, ostiole slightly elevated, 13–17 μ in diameter; spores oblong with rounded ends, chiefly 1-septate, hyaline, occasionally non-septate but never 2-septate, the septum centrally placed and quite distinct, with 2 to 4 guttulae, $8-12 \times 2.5-5 \mu$.

Maculis in foliis amphigenis rotundatis, brunneis, friabilibus 2–5 mm. diametris supra sed non infra annulo purpureo diluto cinctis, pycnidiis abundantibus sparsis in medietate folii sitis per utramque paginam pertusis, luteis aut gilvis membranaceis et paulo carbonaceis circa ostiolum 90–170 μ diametris; ostioliis minimum elevatis et 13–17 μ diametris; sporidiis oblongis utrimque rotundatis hyalinis semel septatis nonnumquam continuus sed numquam bis septatis, septo in medietate sporidii et distincto, $8-12 \times 2.5-5 \mu$.

On living leaves of *Plantago Rugelii* Dcne., Homer, Champaign County, Ill., June 6, 1929. Acc. No. 22, 014 (type).

Stagonospora Scirpi sp. nov.

Folicole, without spots; pycnidia immersed in the tissue of leaves and sheaths, arranged in rows between the veins, mem-

branaceous, subspherical to applanate, dark olivaceous, 80–205 μ in diameter; ostiole slightly raised and protruding, somewhat carbonized, 12–20 μ in diameter; spores hyaline, oblong to elongate-oval, obtuse at both ends, generally 4-septate but occasionally 3- or 5-septate, 20–28 \times 5–6.5 μ .

Pycnidiis in laminis vaginisque foliorum immersis in seriebus longitudinalibus inter venulas dispositis membranaceis subsphaericis aut applanatis atratis olivaceis 80–205 μ diametris, ostiolis leniter elevatis nonnihil carbonaceis pertundentibus 12–20 μ diametris, sporidiis hyalinis oblongis aut elongatis ovalibus utrinque obtusatis ut plurimum quater sed etiam ter et quinquies septatis 20–28 \times 5–6.5 μ .

On leaves and sheaths of *Scirpus atrovirens* Muhl., Duquoin, Perry County, Ill., June 13, 1930. Acc. No. 22, 259 (type).

This is apparently the first report of a *Stagonospora* on a North American *Scirpus*. Forms of the genus previously observed on species of *Scirpus* elsewhere have generally been assigned to two species, *Stagonospora aquatica* Sacc. and *S. scirpicola* Pass. Within the first three subspecies, *junciseda* Sacc., *Karstenii* Sacc., and *lacustris* Sacc., and a variety, *sexseptata* Trail, have been distinguished. All are 3-septate with respect to their spores except the variety *sexseptata*, and the finer distinctions appear to have been made on the basis of spore shape and dimension. It would appear advisable, from the present mycological point of view, to regard Trail's variety as a distinct species, for which the name *Stagonospora sexseptata* (Trail) comb. nov. may be proposed.

The forms on *Scirpus* appear capable of being distinguished on the following basis.

Spores chiefly 3-septate.

Spores 25 μ or more long, not less than 3 μ wide.

Spores not over 30 μ long.

Spore width 5–6 μ .

Spore width 3–4 μ .

Spores up to 40 μ long, 6–8 μ wide.

Spores less than 20 μ long, 2–3 μ wide.

Spores generally more than 3-septate.

Septa usually 4.

Septa usually 6.

S. aquatica.

S. aquatica lacustris.

S. aquatica Karstenii.

S. scirpicola.

S. Scirpi.

S. sexseptata.

Aristastoma gen. nov.

Genus Sphaerioidacearum hyalophragmiarum ab *Stagonospora* circulo setarum circum ostiolum distinctum, pycnidiis sphaericis innatis vel erumpentibus ostiolatis et cum ostiolo circulo setarum coronato; sporidiis oblongis ter vel plus septatis hyalinis.

***Aristastoma concentrica* sp. nov.**

Folicole, causing circular spots 3–8 mm. in diameter, these marked above by alternating concentric zones of red and white tissue, the margin red, and beneath unzoned and brownish red, not friable; pycnidia spherical to applanate, arranged irregularly in the white zones of the spots only, erumpent epiphyllously only, membranaceous except near the ostiole, 180–270 μ in diameter, ostiole circular, 25–35 μ in diameter, crowned by a ring of more or less upright setae, these blackish at the base, elsewhere dark brown, septate, blunt; straight 20–65 μ long by 6.5–10 μ wide; spores oblong, 1- to 4-, mostly 3-septate, 15–35 \times 4.5–6 μ . (PLATE 34, FIGS. 10–14.)

Maculis in foliis rotundatis non friabilibus, 3–8 mm. diametris supra zonis concentricis miniatis et albidis et marginibus miniatis notatis infra sine zonis et rubiginosis, pycnidiis sphaericis in zonis albidis solim dispositis per paginam superam solim erumpentibus membranaceis 180–270 μ diametris, ostiolis rotundatis 25–35 μ diametris circulo setarum erectarum brunnearum septatum obtusatum rectarum 20–65 μ longarum coronatis, sporidiis oblongis semel ad quater sed plurimum ter septatis 15–35 \times 4.5–6 μ .

On leaves of *Vigna sinensis* Endl., Metropolis, Massac County, Ill., Oct. 12, 1927. Acc. No. 5453 (type).

This remarkable disease of cowpea leaves presents several interesting features. In the lesion itself there is the regular alternation of red and white concentric zones as well as limitation of the pycnidia to the white zones, while in the fungus the ring of setae is very distinctive. There is, as shown in plate 34, figure 13, also a very apparent structure in the ostiole, a light colored tissue apparently breaking away from a specialized, annulus-like ring of cells.

***Septoria Cunillae* sp. nov.**

Folicole, spots diaphyllous, irregularly circular, 2–5 mm. in diameter, chestnut brown above, concentrically zoned and with a narrow purple border, grayish brown beneath; pycnidia very few per spot (6–12 in the largest), scattered, situated in the pallisade tissue and opening epiphyllously by a very slight protrusion of the papilliform ostiole, carbonaceous at maturity, spherical or irregularly shaped by the crowding of host cells, 35–60 μ in diameter; ostiole round, 10 μ in diameter; spores hyaline, straight, curved, or bent, acute at both ends, the upper end somewhat larger, continuous or remotely septate, 15–40 μ long by about 1.5 μ wide.

Maculis amphigenis irregulariter rotundatis 2-5 mm. diametris brunneis cum zonis pallidis supra viridulis infra; pycnidiis paucissimis sparsis sub epidermide sitis per superam paginam pertudentibus carbonaceis sphaericis 35-60 μ diametris; sporidiis hyalinis rectis curvisve utrimque acutatis continuis vel remote septatis, 15-40 μ longis circiter 1.5 μ latis.

On *Cunilla origanoides* (L.) Britt., Alto Pass, Union County, Ill., June 13, 1927. Acc. No. 22, 557 (type).

***Septoria eupatoriicola* sp. nov.**

Folicle, spots extending through the leaf, light brown above, tan below, sunken, not friable, 1-2.5 mm. in diameter, surrounded above by a diffused purple halo of variable extent; pycnidia scattered, developing in the mesophyll and opening either above or below, not strongly beaked and not protruding, membranaceous, brown, up to 115 μ in diameter, ostiole very slightly carbonized, circular, wide, 60-80 μ in diameter; spores hyaline, somewhat obclavate, straight or only slightly curved, blunt at the base, acute at the apex, 3- to 7- but chiefly 5-septate, 30-70 μ long, about 1.5 μ wide.

Maculis in foliis amphigenis brunneis supra brunneolis infra non friabilibus 1-2.5 mm. diametris in pagina supra cum circulo purpureo cinctis, pycnidiis sparsis in medietate folii sitis sed aut supra aut infra paulo pertudentibus membranaceis brunneis usque 115 μ diametris, ostiolis latis 60-80 μ diametris, sporidiis hyalinis nonnihil clavatis rectis aut solim leniter curvis obtusis base acutatis apice ter ad septiens sed ut plurimum quinquiens septatis 30-60 μ longis circiter 1.5 μ latis.

On leaves of *Eupatorium perfoliatum* L., Duquoin, Perry County, Illinois, June 13, 1930. Acc. No. 22, 260 (type).

In North America *Septoria Eupatorii* Rob. & Desm., has been reported to occur on *Eupatorium serotinum* Michx. and *E. urticifolium* Reich. Its spores are reported to be between 25 and 35 μ long. Sydow has described *Septoria albomaculans* on *E. nubigenum* Benth. and *E. pomaderrifolium* Benth. from Guatemala, which is said to form snow white spots, to have pycnidia between 120 and 170 μ in diameter, and to produce spores 35-52 μ long. The variability in spore length, pycnidial size and spot characters appears to distinguish our Illinois material quite strongly.

LEPTOTHYRIUM POMI (Mont. & Fries) Sacc.

A specimen on the fruit of *Prunus americana* Marsh., taken near Beechville, Calhoun County, Ill., Sept. 16, 1926 (Acc. No. 7, 736) appears to be of interest. It is identical with our

many collections of "fly speck" on apple, even to the extent of being sterile. This report adds another host to the American list. It is noteworthy that previously the "fly-speck" fungus was known to occur only on *Prunus Persica* (L.) Stokes, *P. serotina* Ehrh., and on "prune." On the first it was reported as *L. pomi*, on the second as *L. cinctum* Cooke.

Confertopeltis gen. nov.

Genus *Leptostromatacearum* hyalosporarum cum pycnidiis dimidiatis sed bene rotundatis ostiolatis nonnumquam solitariis sed saepissime in stromatibus exilibus confertibus, in epidermide sitis sed erumpentibus, sporidiis bacillaribus, et mycelio extimo filiforme proximo radiatim compaginato.

Confertopeltis Asparagi sp. nov.

Stromata variable in size, $300 \times 250 \mu$ when with one pycnidium to $1200 \times 425 \mu$ when with many; pycnidia hemispherical, ostiolate, membranaceous, $150-225 \mu$ in diameter, closely set in the irregularly shaped stroma, composed chiefly of aliform mycelium; ostiole circular, definite, $10-15 \mu$ in diameter, at maturity surrounded by a narrow zone of carbonized cells; spores hyaline, non-septate, rod-like, straight or slightly curved, minute, $2.5-3 \times 1-1.5 \mu$; conidiophores minute, simple. (PLATE 34, FIGS. 15-18.)

Stromates variables $300-1200 \times 250-425 \mu$ diametris cum pycnidiis rotundatis ostiolatis membranaceis $150-225 \mu$ diametris in stromatibus contiguis locatis, ostioliis rotundatis $10-15 \mu$ diametris carbonaceis, sporidiis hyalinis continuis bacillaribus rectis vel leniter curvatis $2.5-3 \times 1-1.5 \mu$, basidiis minutis simplicibus.

On arid stems of *Asparagus officinalis* L., Villa Ridge, Pulaski County, Ill., Nov. 10, 1927. Communicated by G. L. Stout. Acc. No. 7295 (type).

This fungus fruits in elongated oval spots on the stems and branches of its host and unless examined closely may be taken for the lesions and telial sori of *Puccinia Asparagi* DC. The pycnidia are developed beneath stomata, through which the ostioles at first open, but eventually the entire stroma becomes more or less erumpent. The spots are definite, rather large and quite characteristic, having in the center a cinereous area which is surrounded first by a zone brown tinted and then by a narrow zone of dark brown. Though not radiate in structure, both the pycnidial cover and the uppermost layer of the stroma are composed of cells which have a distinct aliform aspect. While this

characteristic is very distinct throughout the stroma, the extensive mycelium which occupies the superficial host cells quickly varies to the conventional cylindric form, with clusters of aliform cells at infrequent intervals.

Cribropeltis gen. nov.

Genus *Leptostromatacearum* hyalosporarum cum mycelio superficiali extento clathrato interstitia cuius cum ramis brevibus cerebriformibus opplentur, pycnidiis dimidiatis nigrifactis discretis irregulariter fissuratis distinctis a mycelio suo nigrore et praeterea densa compositione suarum cellarum, basidiis simplicibus, et sporidiis hyalinis continuis ovalibus vel oblongis.

Etymology: *cribrum*, a sieve, and *pelta*, a shield.

Cribropeltis citrullina sp. nov.

Mycelium brown, straight, 3–4 μ in diameter, septate at intervals of 5–15 μ , much branched, the main strands forming with its large branches an open lattice the interstices of which, on and near the pycnothyrium, are filled with short, cerebriform, terminate branches; pycnidia without an ostiole, black but not carbonized, 300–600 μ in diameter, irregularly circular and not clearly distinguishable at the margin from the mycelial subicle, opening by long, narrow, irregular fissures; conidiophores simple, hyaline, clavate, 5–6 \times 2–3 μ , arising from a thin, hyaline basal layer beneath the scutellum; spores non-septate, hyaline, oblong with rounded ends, straight or slightly curved, 10–15 \times 4–5 μ . (PLATE 34, FIGS. 19–21.)

Mycelio bruneo recto 3–4 μ diametro intervallis 5–15 μ septato ramoso et clathrato interstitia cuius in pycnidiis et prope ea cum ramis brevibus cerebriformibus complentur sed exterius solum partim vel haud opplentur, pycnidiis nigrifactis sed non carbonaceis 300–600 μ diametris depressis et non a mycelio clare distinctis, basidiis simplicibus hyalinis erectis clavatis 5–6 μ longis 2–3 μ latis ex strato hyalino basilari sub pelta oriundis, sporidiis continuis hyalinis oblongis rectis vel leniter curvis, 10–15 \times 4–5 μ .

On the fruit of *Citrullus vulgaris* Schrad., Spring Bay, Woodford County, Ill., Sept. 30, 1927. Acc. No. 22, 882 (type).

This fungus forms "fly specks" on the fruit of the watermelon but appears to differ from most of the "fly speck" fungi in having an extensive superficial mycelium, which covers, at times, areas several centimeters wide. The pycnothyria are usually abundantly developed and may come to maturity and disintegrate before the vegetative mycelium disappears. Its most remarkable character appears to be the latticed mycelium of a regular cylindrical type from which arise, especially on and near the

pycnothyria, short aliform branches in such numbers as to entirely fill the interstices.

Discosia Potentillae sp. nov.

Spots cinereous to white with a red border, up to 5 mm. in diameter, pycnidia epiphyllous and hypophyllous, scattered, abundant, circular, sometimes confluent or contiguous, entirely superficial, carbonaceous except at the margin and there evidently radiate in structure, 120–250 μ in diameter, ostiole rounded, more completely carbonized on the slightly raised rim, 15–30 μ in diameter; spores hyaline, curved, blunt at both ends, 3- and 4-septate, 10–15 \times 2.5–3.5 μ , furnished at each end with a fine bristle often 7.5 μ long which arises from the inner curve of the spore.

Maculis cinereis aut albescentibus cum marginibus rubris usque 5 mm. diametris, pycnidiis aut in pagina supera aut infera sparsis abundantibus rotundatis nonnumquam contiguis vel confluentibus superficialibus carbonaceis sed in marginibus translucidis et ibi radiantibus 120–250 μ diametris, ostioliis rotundatis carbonaceis leniter elevatis 15–30 μ diametris, sporidiis hyalinis curvis utrimque obtusis ter et quater septatis, 10–15 \times 2.5–3.5 μ cum arista utrimque 7.5 μ longa.

On leaves of *Potentilla canadensis* L., at Marlow, Jefferson County, Ill., Sept. 7, 1926. Acc. No. 22, 390 (type).

Lophodiscella gen. nov.

Genus Excipulacearum hyalosporarum cum pycnidiis hysteriformibus sub cuticula locatis ovalibus discretis membranaceis fissis longitrorsum patefacientibus, sporidiis magnis continuis non catenulatis, et mycelio paulo radiatim formato.

Lophodiscella Asparagi sp. nov.

Caulicolous, in indefinite, straw-colored, extensive spots; exciples subcuticular, oval, membranaceous, rimose, 130 \times 100 to 300 \times 165 μ ; spores hyaline, oblong, straight or curved, large, non-septate, 11 \times 4.5 to 20 \times 6 μ ; conidiophores simple, minute. (PLATE 34, FIGS. 22–27).

Caulogena maculas magnas indeterminatas stramineas incolente, cum pycnidiis excipuliformibus sub cuticula locatis ovalibus membranaceis rimosis 130–300 μ longis 100–165 μ latis, sporidiis hyalinis oblongis rectis curvisve magnis continuis 4.5–6 \times 11–20 μ , basidiis simplicibus minutis.

On arid stems of *Asparagus officinalis* L., Villa Ridge, Pulaski County, Ill., Nov. 10, 1927. Acc. No. 7576 (type). Anna, Union County, Ill., Nov. 10, 1927, Acc. No. 7597; Alto Pass, Union County, Ill., Nov. 26, 1926, Acc. Nos. 7603 and 7740.

This genus appears to differ from *Lophodermopsis* Speg. chiefly in having non-catenulate spores and from *Psilospora* Rabenh. in being more nearly like *Lophodermium* than other hysteriaceous forms in its appearance. The mycelium adjacent to the exciples lies between the epidermal cells and the cuticle and forms a loose pseudoradiate plate; but a radiate structure cannot be demonstrated for the mycelium constituting the pycnidial cover. The thick basal plectenchyma appears to give rise, directly, to the conidiophores.

***Colletotrichum aeciicolum* sp. nov.**

Acervuli irregularly circular, sessile, 120–165 μ in diameter; setae marginal only, curved, multiseptate, blunt at the apex, orange-yellow, 200–700 but mostly 500–550 μ long by 3.5–4 μ wide; conidiophores densely crowded, orange-yellow in mass, clavate, 4–6.5 μ long by 2–2.5 μ wide; spores rod-like, hyaline, straight or slightly curved, usually biguttulate, the guttulae polar, but often eguttulate or with 4 evenly spaced guttulae, 7–12, mostly 8–10, by 2–3 μ .

Acervulis irregulariter rotundatis sessilibus 120–165 μ diametris setis curvatis multiseptatis aurentiacis apicibus obtusatis 200–700 μ longis, circumclusis basidiis densis in massa aurentiacis clavatis 4–6.5 \times 2–2.5 μ , sporidiis bacilliformibus hyalinis rectis aut leniter curvis ut plurimum cum duabus polaribus guttulis, 7–12 \times 2–3 μ .

On the unruptured peridia of aecidia of *Puccinia Asterum* Kern in leaves of *Solidago canadensis* L., Beechville, Calhoun County, Illinois, Sept. 16, 1926. Acc. No. 22, 416 (type).

***Colletotrichum Smilacis* sp. nov.**

Folicle, infections at first apical or marginal but soon extending downward along the veins and laterally through the leaf tissue for large distances and eventually blighting more than half of the leaf, diseased tissue at first brown, later cinereous with brown margins; acervuli very abundant in the lesions, narrowly oval to circular in outline, 45–100 μ in diameter, epiphyllous only, developed beneath the cuticle and consisting of a basal mass of dark brown hyphal cells resembling a sclerotium, a layer of hyaline mycelium, conidiophores, spores and setae. Conidiophores hyaline, 6–10 \times 3.5 μ ; spores produced apically, hyaline, curved, non-septate, acute at both ends, 17–22 \times 3.5–4.5 μ ; setae dark brown, straight or variously bent, arising from a bulbous basal cell, continuous or septate, the septa always faint, dilutely colored at the acute tip, 45–125 μ or more long, 4–6.5 μ

wide near the base, chiefly marginal but some protruding through the interior of the acervulus and these much longer larger and darker than those on the margin.

Acervulis in maculis maximis cinerescensibus abundantissimis anguste ovalibus aut circularibus $45-100\ \mu$ diametris solim epiphyllis sub cuticula locatis ex strato atrato sclerotiforme basillare ex strato hyalino ex strato conidifero et ex setis compositis, setis atratis brunneis rectis vel varie curvis continuis aut septatis apice acutis base in cella magna rotundata sistantibus ut plurimum in marginibus sed ullis in centris acervulorum et hae semper maiores longiores et atratiores; basidiis hyalinis $6-10 \times 3.5\ \mu$; sporidiis acrogenis hyalinis curvis continuis utrinque acutis $17-22 \times 3.5-4.5\ \mu$.

On living leaves of *Smilax hispida* Muhl., Olney, Richland County, Ill., Sept. 21, 1932. Acc. No. 22, 849 (type).

Colletotrichum Dioscoreae sp. nov.

Acervuli abundant in the diseased areas, discrete, contiguous or confluent, round to oval, $50-120\ \mu$ in diameter; setae numerous, marginal except through the confluence of acervuli, black, acute, septate, with a bulbous base, up to $145\ \mu$ long but chiefly $60-80\ \mu$ long; conidiophores minute and hyaline; spores hyaline, non-septate, straight or curved, very variable in size but chiefly $17-18 \times 6\ \mu$.

Acervulis in maculis emortuis abundantibus discretis contiguus vel confluentibus rotundatis vel ovalibus $50-120\ \mu$ diametris, setis numerosis nigris septatis acutis base bullatis $60-145\ \mu$ longis, basidiis minutis hyalinis, sporidiis hyalinis continuis rectis vel curvis variabilissimis sed ut plurimum $17-18 \times 6\ \mu$.

On *Dioscorea villosa* L., Marlow, Jefferson County, Ill., Sept. 7, 1926. Acc. No. 22, 420 (type).

In the type material, the fungus resides in spots on the leaves. These spots are extensive, ranging from small irregular circles of a centimeter in diameter to one-half or more of the leaf. The acervuli occur on both surfaces but are several times as abundant on the upper surface. The spots are at first dark brown and marked concentrically with darker bands but eventually become cinereous and fragile.

Marssonina salicina sp. nov.

Folicle, spots extending through the leaves, brown, circular, $0.5-2\ \text{mm.}$ in diameter, the larger spots with a narrow, darker brown border; acervuli minute, scattered, circular in outline, strictly hypophyllous, $50-80\ \mu$ in diameter; spores hyaline, septate above the middle, curved, blunt at both ends, $20-35 \times 3-4\ \mu$.

Maculis in foliis amphigenis brunneis rotundatis 0.5–2 mm. diametris majores quarum cum marginibus angustis et aterioribus, acervulis minutis sparsis rotundatis in pagina infera solim sitis 50–80 μ diametris, sporidiis hyalinis supra medietatem septatis curvis et utrimque obtusis 20–35 \times 3–4 μ .

On leaves of *Salix nigra* Marsh., Lincoln, Logan County, Ill., June 18, 1930. Acc. No. 22, 258 (type).

A rather large number of species of *Marssonina* (*Marssonina*) have been described on various species of *Salix*. Those connected with discomycetous perfect forms have received the attention of Nannfeldt,⁹ who has concluded that 10 of the named species are retainable as distinct. Four of these, as indicated by the same author,¹⁰ do not have any demonstrated ascigerous connections. The segregation of species of *Marssonina* into narrowly limited species appears to be upheld, according to Nannfeldt, on the basis that these species show definite relation to ascigerous genera and are, as Klebahn found for the *Populus*-inhabiting forms, of very narrow host range. This, however, is somewhat opposed to the view of Davis,¹¹ who considers that forms found in Wisconsin on *Salix longifolia*, *Salix discolor*, *Salix cordata*, *S. syrticola*, and *S. petiolaris* are all referable to *M. Kriegeriana*.

So far as can be determined from samples and descriptions at hand, the *Salix* species of *Marssonina* appear to be distinguishable with reasonable sharpness in the manner indicated in the following analysis.

Spots black above.

M. nigricans.

Spots brown to cinereous above and below.

Spores consisting of nearly equal cells.

Spore dimensions 12–20 \times 5–6 μ .

M. apicalis.

Spore dimensions 10–15 \times 2.5–5 μ .

M. rubiginosa.

Spores consisting of distinctly unequal cells.

Distal cell larger.

Spore width more than 5 μ .

Spores 22–29 \times 5–8 μ .

M. Lindii.

Spores 18–22 \times 6–9 μ .

M. dispersa.

Spores 16–25 \times 5–7 μ .

M. salicigena.

Spores 15–17 \times 5–8 μ .

M. salicicola.

Spore width less than 5 μ .

M. Salicis.

⁹ Svensk. Bot. Tidsk. 25: 1–31. 1931.

¹⁰ Nova Acta Reg. Soc. Sci. Upsaliensis, IV, 8: 171. 1932.

¹¹ Trans. Wisc. Acad. Sci. 20: 399–411. 1922.

Proximal cell larger.

Spore dimensions $20-35 \times 3-4 \mu$.

Spore dimensions $13-17 \times 3-6 \mu$.

M. salicina.

M. Kriegeriana.

BOTANICAL SECTION

ILLINOIS STATE NATURAL HISTORY SURVEY

URBANA, ILLINOIS.

EXPLANATION OF PLATE 34

Figs. 1-6, *Microthyriella Rubi*. 1, habit sketch; 2-3, surface views of two thyriothecia, showing general structure and method of opening; 4, portion of edge of thyriothecium; 5, an ascus; 6, germinated ascospore surrounded by cells developed from it; fig. 7, *Phyllosticta Smilacis*. Surface view of a pycnidium showing the irregular ostiole and the fringe of subcuticular aliform mycelium; figs. 8-9, *Dendrophoma Zeae*. 8, pycnidium in section; 9, part of a conidiophore; figs. 10-14, *Aristastoma concentrica*. 10, Cowpea leaflet with spots; 11, spot enlarged, showing zonation and pycnidia in the white zones; 12, side view of pycnidium; 13, view from above, showing unopened ostiole, annulus-like cells, and setae; 14, spores; figs. 15-18, *Confertopeltis Asparagi*. 15, habit sketch; 16, pycnidia in a stroma; 17, aliform cells from top of pycnidium; 18, aliform cells in extra-stromatic mycelium; figs. 19-21, *Cribropeltis citrullina*. 19, pycnothyria enlarged showing the extensive, connecting, superficial mycelium; 20, mycelium from 3 regions: 1, on the pycnothyrium; 2, just beyond its edge; 3, at some distance from it. Note how the interstices of the lattice are filled with aliform cells; 21, spores; figs. 22-27, *Lophodiscella Asparagi*. 22, habit sketch; 23, portion of spot showing distribution of excipula; 24, excipulum enlarged; 25, section of excipulum, showing subcuticular position; 26, subcuticular, extraexcipular mycelium showing rudimentary aliform structure; 27, spores.

A NEW FUNGUS PARASITIC ON NEMATODES

C. D. SHERBAKOFF

(WITH PLATE 35)

In the summer of 1931 the writer decided to make a final examination of certain fungi that had developed in a moist chamber in which a batch of strawberry plants had been kept for about three weeks. In the material, his attention was attracted by a fungus with conidia-like bodies having the form of complete, hyaline rings (PLATE 35, FIGS. I, G, N). The thickness of the hypha in the rings was considerably greater than that of the simple, septate branches on which they were produced. The content of the rings was also more dense than that of the hyphae even at the early stages of their growth; later on the branches were observed to be practically void of protoplasm. In some mounts rings both attached to the mycelium and detached were observed in considerable numbers. The detached rings were without any remnants of the hyphae (PLATE 35, FIG. N). Thus they were plainly differentiated from the mycelium and appeared to answer our usual conception of conidia; they are here considered as such. In most cases the septation was indistinct or absent in the rings (PLATE 35, FIG. N); however, infrequently the septation was quite clearly observed (PLATE 35, FIG. I).

On further examination of the fungus it was found to produce other differentiated bodies, from globular to oval in shape (PLATE 35, FIGS. E AND H), on branches similar to the conidiophores terminating with the rings. These resemble young terminal chlamydospores so common in some species of *Fusarium*. Besides these two no other differentiated bodies were observed; and from the beginning it was suspected that the globular bodies were the first stage in the development of the ring-shaped conidia, even though it was not easy to visualize the process of development from the first to the second stage. However, in the material observed this year it was found that the globular bodies at a certain time send out a somewhat pointed tube which, as it

grows, describes a complete circle, with the lower part of the round bodies as the union point thus forming the ring (PLATE 35, FIGS. A, B, C AND D). During this process of formation, the globular body shrinks noticeably in its diameter though even in the completed rings its position is usually marked by a broader part in them. The intermediate stages between the globular and the ring-shaped forms were seldom observed, because apparently the process of development is rapid.

In all of the material examined, various living nematodes were working their way through the maze-like growth of this and various other fungi—mostly *Rhizoctonia* and various species of *Mucor* and *Fusarium*. Shortly after the ring-spored fungus was first found some nematodes were observed with from one to several of the rings over the anterior ends of their bodies (PLATE 35, FIGS. J, K AND L³). Some of the rings were so tightly set on the nematode bodies that there was apparently no chance for the nematodes to slip out of them. It was clear that the more they wiggled the tighter were the rings pushed on. Some of the rings, with the nematodes caught in them, were still attached to the mycelium, and the nematodes were thus firmly held in the place. The writer observed many instances of nematodes entering into the rings, and it was evident that with the forward movement of the nematodes the rings were pushed farther and farther over their tapering bodies until they could be pushed no more. Nematodes were observed to escape in only a few cases.

The observations at once suggested the idea that the fungus was a parasite of the nematodes and that the ring-shaped conidia were a special adaptation of the fungus to the host. In the ring the fungus had a device well suited for the purpose of catching and holding the nematode so as to enable the fungus to grow into and consume it. On several occasions the fungus growth appeared as a cleverly set up network of loop-shaped nematode traps. This device, for its purpose, seems to be at least as good as the loop of the man-made lasso. The present instance of the biological adaptation seems to the writer to be quite an interesting illustration of a mutational rather than gradual development of the species. At least it is hard to see any benefit to the fungus

in anything less than a complete ring, for the purpose of catching nematodes. The idea of parasitism was fully justified later by an observation of a number of dead nematodes, with from one to several of the rings still visible over their bodies and completely filled with the mycelium (PLATE 35, FIGS. B, AND L¹ AND L²). In still later stages only the fungus could be seen, the nematode's body evidently having completely disintegrated. After the development of the fungus in the nematodes it grows out usually by a single straight tube from one or both ends of the nematode. The mycelium that develops outside of the nematode produces at first the globular bodies (PLATE 35, FIGS. E AND H) which sooner or later develop into the rings, in the manner described above. No actual experiments were performed to prove a parasitic relationship.

Although the rings on the nematodes were observed for as much as three consecutive hours, no germination was observed. Germination outside of the nematodes was observed in only one case. In that instance (PLATE 35, FIG. I) the ring produced a short hypha, which terminated in a globular body. Lack of germination was probably due to the unfavorable environment, between the glass slide and cover slip, in water. A few attempts to grow the fungus from the ring-shaped conidia, by a dilution, in potato tuber decoction, dextrose agar, were entirely unsuccessful. A few plantings of ring-bearing nematodes upon the surface of agar have been up to this time also unsuccessful.

The fungus was observed to attack nematodes of the genera *Aphelenchus*, *Cephalobus*, *Dorylaimus*, and *Rhabditis*, as determined by Dr. P. H. Hornburg, and apparently also larvae of some minute flies.

The writer has never before observed a fungus similar to this and does not recall any reference in the literature to any of a similar kind. During the first days of the writer's study of the fungus, because of its unusual appearance and rather striking adaptation to trapping nematodes, it was shown to several members of this Department, Dr. Hornburg included. The latter, looking over the chapter on nematodes in Sorauer's text book on plant diseases (volume 4, 1925) found there, on pages 5 and 6, a brief reference to Zopf's paper on a fungus parasitic on

nematodes which had some peculiar "loops" (Ösen) with which to catch them. Examination of the original paper by Zopf¹ showed that his fungus, *Arthrobotrys oligospora*, was clearly different. The loops, in *A. oligospora*, are those of a three dimensional network (PLATE 35, FIG. M) produced by a peculiar bending over of the hyphal tips toward the same hypha or other hyphae and fusing with them; from about the middle of the bow-shaped portion of the loop thus formed grows out another branch which duplicates the process just described; this is repeated over and over again which gives rise to a complicated network of loops. The hyphae forming the loops are identical with the rest of the mycelium. Later on in the studies, the author was fortunate to find also *A. oligospora*, which was observed growing in association with and separately from the ring fungus. In the cases observed, Zopf's fungus readily produced typical, pear-shaped, one-septate conidia of *Arthrobotrys*, while the other under the same conditions never was observed to produce anything else but the globular bodies and the rings. In Zopf's paper was described another fungus, producing hook-shaped conidia, *Harposporium Anguillulae*, parasitic on nematodes which is also clearly a different organism. Thus, so far as the writer is aware the fungus is new.

The families of the Fungi Imperfecti, as they are now described, are such that this new fungus could not be placed in any of them. However, it seems that it could be readily placed with the group of fungi producing spiral conidia, Helicosporae, if the description were properly emended.

In "Genera of Fungi," by F. C. Clements and C. L. Shear, page 209 (1931), the description of Helicosporae reading "Conidia spirally curved . . ." etc., should be emended to read: "Conidia spirally curved or in form of rings . . ." etc. And in the key, under paragraph B, should be added a third line as follows: "3. Conidia in form of closed rings . . . *Anulosporium*."

The fungus could not be placed in any of the described genera and therefore is considered to be a new genus with the following description:

¹ Zopf, Wilhelm. Zur Kenntnis der Infektions-Krankheiten niederer Thiere und Pflanzen. Nova Acta Leop. 52: 315-376. 7 pls. 1888.

Anulosporium gen. nov.

Hyphae septate, hyaline; conidia single, terminal, in shape of rings.

Anulosporium nematogenum sp. nov.

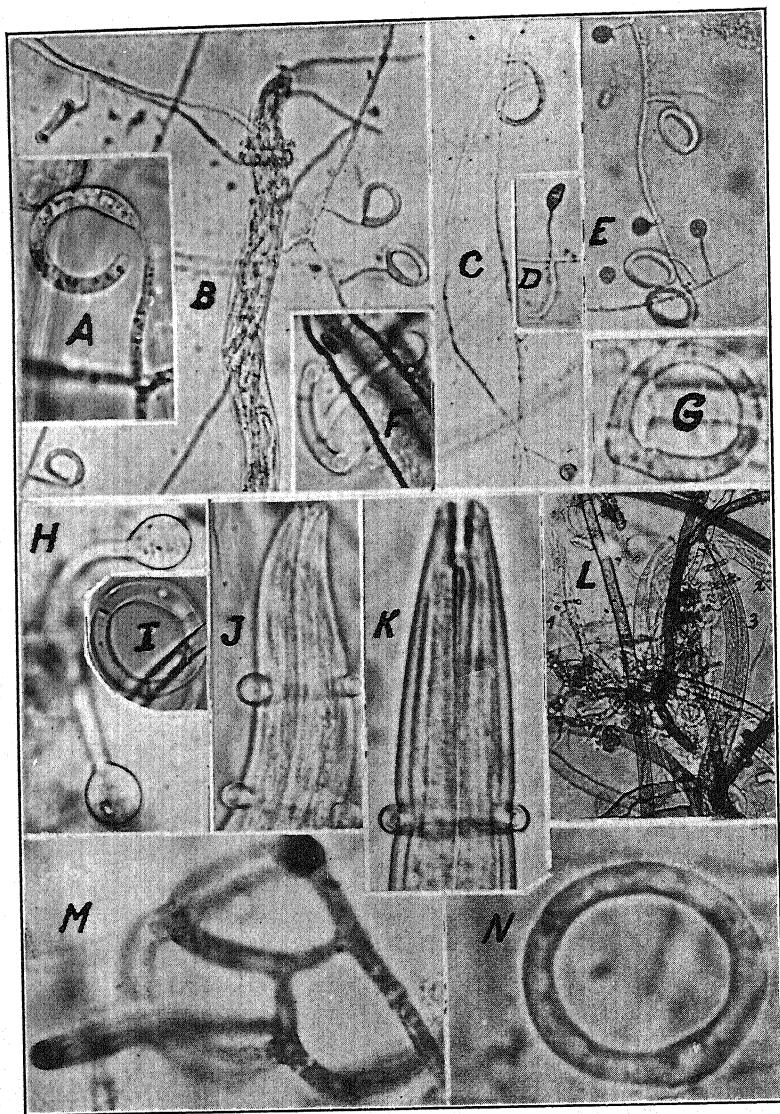
Hyphae septate, hyaline, 1.7–2.2 μ in diameter when they grow outside of the host, and 2.5–3.5 μ in diameter when they grow inside of the host; conidia with mostly indistinct septation though sometimes clearly, usually 3-septate, hyaline, 2.5–3.5 μ in diameter, forming rings 13–23 μ , mostly about 18 μ , outside diameter; conidiophores simple, sometimes septate, 20–30 μ long.

Hab. parasitic on various nematodes and on larvae of some minute flies, in association with strawberry plants, in Tennessee.

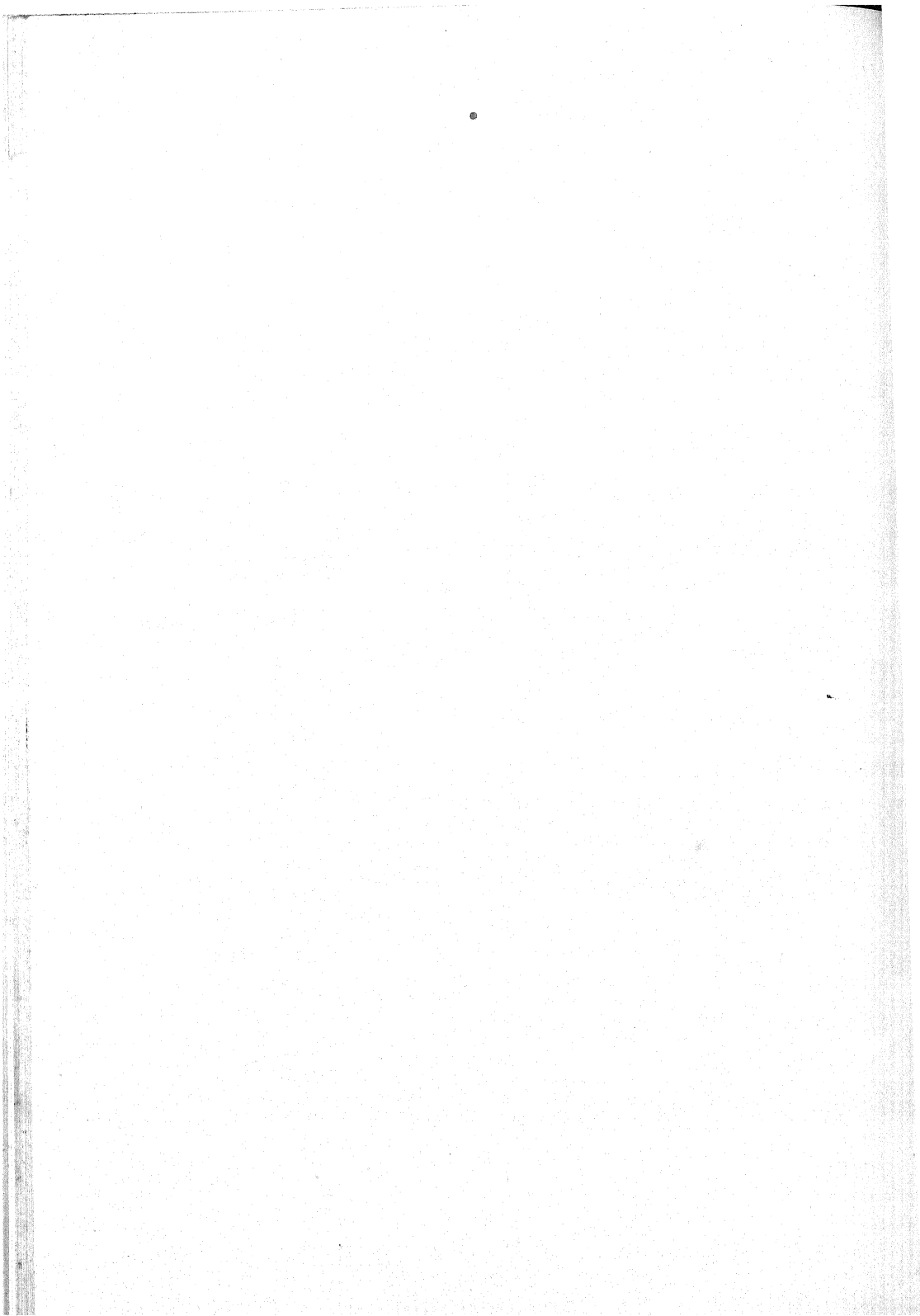
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF TENNESSEE.

DESCRIPTION OF PLATE 35

Anulosporium nematogenum. A, a nearly completed development of the ring; 1000 \times . B, a nematode filled with the fungus growth, with two of the rings over the nematode's body still visible; and the growth outside of it, with two completed and two nearly completed rings; 400 \times . C, one of the globular bodies and one ring in the process of its development; 400 \times . D, a young conidium at the beginning of its development into a ring-shaped form; 400 \times . E, globular and ring-shaped stages, and the mycelium; 400 \times . F, a germinated ring, with the germ tube terminated in a globular conidium; 1000 \times . G, one of the rings; 1000 \times . H, two globular conidia; 1000 \times . I, a ring with well defined septa; 1000 \times . J, a nematode with two rings; 1000 \times . K, a nematode with one ring; 1000 \times . L: 1, a completely disintegrated nematode with the ring, in cross section, still visible; 2, a nematode filled with the fungus; 3, a still living nematode with three rings on it. A number of the rings could be detected in the field. 300 \times . M, a three-dimensional system of loops of *Arthrobotrys oligospora*; 500 \times . N, one of the rings highly magnified; 2000 \times .



ANULOSPORIUM NEMATOGENUM



OBSERVATIONS ON *LAGENA RADICICOLA*

J. H. L. TRUSCOTT¹

(WITH TEXT FIGURES)

Lagena radiculicola was reported first by Vanterpool and Ledingham² from a few localities in Saskatchewan. It is an obligate parasite of the roots of various cereals and wild grasses. The new genus was provisionally placed in the family Ancylistaceae and its possible relationship to the genus *Pythium* was noted.

The purpose of this paper is to report the occurrence of the fungus in soil from Vineland, Ontario, and to present some new observations on its morphology and host range.

The fungus was obtained from Vineland soil in the fall of 1931 on the hosts mentioned by Vanterpool and Ledingham, namely, wheat, barley, rye and maize, and during the summer of 1932 it was found in several fields in the Vineland district on *Agropyron repens* (L.) Beauv. and a number of other wild grasses.

A brief description of *L. radiculicola* is necessary for purposes of comparison. The vegetative phase consists of simple (FIG. 1) or lobed sacs suspended in the lumina of cortical cells of young rootlets. A definite neck (FIG. 1) connects the sac to the cell wall and marks the place where infection by a zoöspore occurred. An exit tube (FIG. 2) grows out from the neck and at its distal end expands to form a vesicle into which flow the contents of the sac. Zoöspores are delimited in the vesicle (FIG. 3) and are freed after its rupture. The zoöspores are reniform and biciliate and the whole process of zoöspore discharge resembles that of the genus *Pythium*. Structures similar to those which function as sporangia may function as gametangia. The contents of one sac passes through a conjugation tube into a second sac (FIG. 7) and a resting spore (FIG. 9) is produced in the latter. Germination of the resting spores has not been seen.

¹ This work was done during the tenure of a Bursary from the National Research Council of Canada, in the Laboratories of the Department of Botany, University of Toronto. I am indebted to Professors D. L. Bailey and H. S. Jackson for their interest and advice.

² Vanterpool, T. C., and G. A. Ledingham. Studies on "Browning" root rot of cereals 1. The association of *Lagena radiculicola* N. Gen.; N. Sp., with the root injury of wheat. Can. Jour. Res. 2: 171-194. 1930.

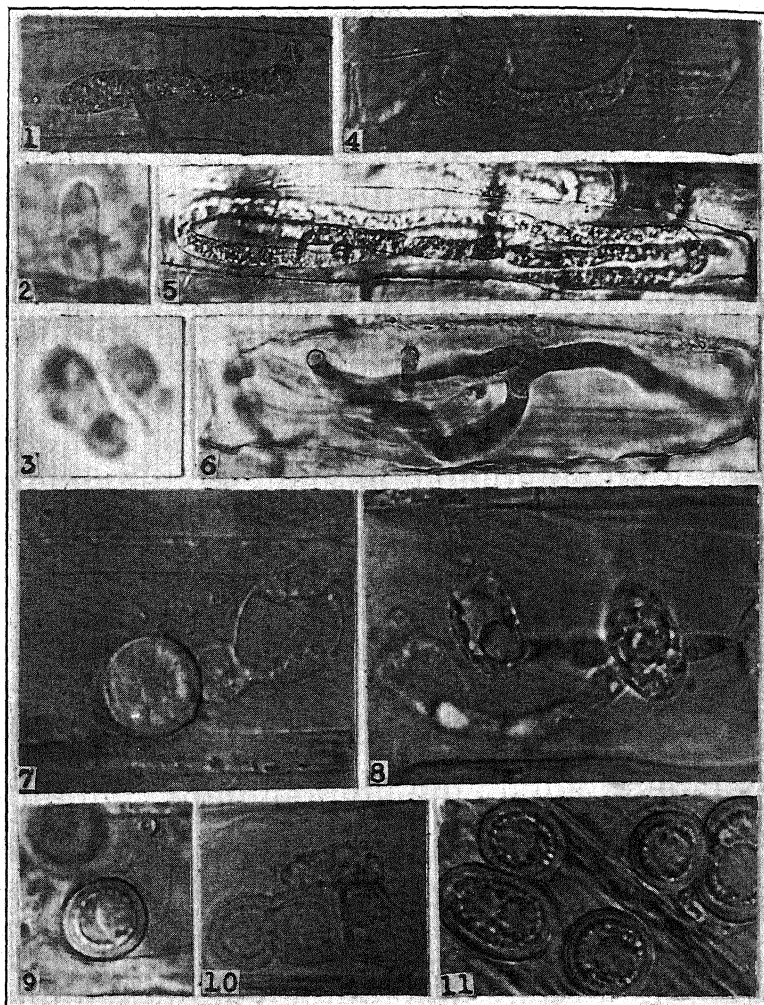


FIG. 1. A young sporangium of the Ontario *Lagena* showing the neck attaching it to the cell wall, $\times 470$; 2, an exit tube, $\times 1400$; 3, zoospores in motion inside a vesicle, $\times 1400$; 4, 5, and 6, variations in the form of sporangium of the Ontario fungus, $\times 470$; 7, a type of fertilization common to both the Ontario and the Saskatchewan forms of *Lagena*, $\times 1400$; 8, multiple fertilization in the Saskatchewan fungus. Two male thalli are in the act of fertilizing the female thallus (center) and a third male thallus has made contact with the female, $\times 1400$; 9, Ontario form showing a mature resting spore within a female thallus. The opening of the neck is shown, $\times 1400$; 10, a compound resting spore of the Ontario fungus, $\times 1400$; 11, forms of resting spores of the Ontario fungus, $\times 1400$.

The illustrations to which reference has been made are all of the Ontario fungus and a comparison with the figures published by Vanterpool and Ledingham will show how closely they agree. In the Ontario form however, the sporangia are *typically* branched (FIGS. 4, 5, 6). This character is so consistent that infections of Marquis wheat grown in Vineland soil may be distinguished readily from those obtained in the same host grown in Saskatchewan soil when both soils are under essentially the same conditions on a greenhouse bench.

While comparing the two forms in the living condition an example of multiple fertilization was noted for the first time in the Saskatchewan form. Figure 8 shows three male thalli in the process of fertilizing a single female thallus. Multiple fertilization has not been seen in the Ontario form, probably because the gametangia are usually so closely entwined that the chances of seeing the connecting tubes are small; but, evidence has been secured that more than one resting spore may be produced in a single female thallus. Rows of as many as six spores resting side by side suggest that they were borne in one gametangium, and in such cases the very thin wall of a gametangium may often be seen to at least partially enclose these spores. Figure 10 illustrates an unusual type of spore found thus far only in the Ontario fungus. One of these spores is compound: the wall between two of the components has not developed completely across the spore while the second cross wall is complete.

Numerous unsuccessful attempts to obtain these fungi in pure culture have been made by means of zoospore inoculations on the roots of a susceptible host grown under aseptic conditions. Until that is accomplished it is impossible to decide whether or not the differences between the Saskatchewan and Ontario forms of the genus *Lagena* have any taxonomic significance. It is quite possible that more than one species exist in both soils, but the branched and larger sporangium which is more typical of the Ontario form, intergrades so commonly with the smaller and unbranched sporangium usually seen in the Saskatchewan form, that it is thought unwise to attempt at present any taxonomic separation.

SPECIES OF SCLEROTINIA FROM GRAND MESA NATIONAL FOREST, COLORADO

ROSS W. DAVIDSON AND EDITH K. CASH

(WITH PLATES 36-38)

This paper consists of some of the results of a collecting trip made by the senior author to the Grand Mesa National Forest, Colorado, during the period of June 12 to July 20, 1930. Although the fungi here discussed represent only a small percentage of the total number of collections, it seems that the species of *Sclerotinia* were sufficient in number and interest to justify a separate account.

The Grand Mesa National Forest is on the western slope of the Continental Divide in the west-central part of Colorado, and Grand Mesa Mountain, where most of the species of *Sclerotinia* were obtained, has sufficient moisture from melting snow and summer rains to make possible a rich fungus flora. Most of the fungi were found near the top of the mountain, at an elevation of about 10,000 feet; *Sclerotinia gregaria*, however, occurred approximately 2,000 feet lower, several miles down the mountain from Mesa Lakes.

It was not found possible to study the complete life history of any of these species, but a few observations were made on the imperfect stages of some of them. A *Botrytis* fruiting form appeared on sclerotia of *Sclerotinia Veratri* and *S. coloradensis* when they were placed in damp sand. This is not unusual as *Botrytis* has long been considered an imperfect stage of many of the species of *Sclerotinia*.

A more interesting observation was made in connection with the species on *Salix*. Green leaves infected with *Sclerotinia foliicola* in the sclerotial stage were found to have an associated imperfect spore form. This is very similar to the *Myrioconium comitatum* Davis (2), which is almost always found associated with *Sclerotium bifrons* on aspen and which has also been reported on *Salix*. The finding of a *Sclerotium* associated with *Myrioconium*

on *Salix* leaves strongly indicates that *Myrioconium* is an imperfect stage of certain species of *Sclerotinia*.

Mr. Ivar Tidestrom has kindly named the specimens of host material with the exception of the *Carex* species, which were determined by the late Dr. H. Hasselbring.

1. *SCLEROTINIA SCLEROTIORUM* (Lib.) DeBary. (PLATE 36, FIGS. 1-3.)

On *Mertensia lanceolata* (Pursh) DC., 388 and 397, June 20; 416, June 23; 445, June 26. Mesa Lakes.

On *Aconitum columbianum* Nutt., 389, June 20. Mesa Lakes.

This *Sclerotinia* was very common in the region on *Mertensia*, fruiting abundantly when first found on June 20 and continuing as late as July 12. In the old stems and among the rotting remains of plant tissue, the large solid sclerotia could easily be found. Frequently several discs occur on a single sclerotium.

It was definitely determined as occurring on the two hosts here given, but it is quite likely that a number of others are also affected. It is thought that it also occurs on the poisonous larkspur common in this region, but this was not definitely demonstrated, although sclerotia were observed on old stems of this plant. The fact that this fungus has been reported on so many herbaceous hosts might lead one to suppose that under favorable conditions it would occur on almost any herbaceous plants. However, observations in the vicinity of Mesa Lakes indicate that it is selective in this respect, for several hosts which grew side by side with *Mertensia* and just as abundantly, were not infected by the fungus. Sclerotia were planted in moist sand in the laboratory, but no conidial or ascus stages developed.

2. *Sclerotinia Veratri* Cash & Davidson, sp. nov. (PLATE 36, FIG. 4.)

The sclerotia are flat, elliptical to irregularly elongate, embedded in stems and, when infection is severe, diffused over considerable area, dark reddish brown to black, white within, 3-7 mm. long by 1-3 mm. broad and 1 mm. thick; apothecia reddish brown, cupulate at first, with inrolled margins, becoming almost flat, usually 3-7 mm. broad, sometimes larger, up to 1 cm., wrinkled when dry, hymenium brown, becoming lighter grayish brown at maturity; stipe black, swollen toward the base, 0.5-1

cm. long by 0.5–1 mm. thick; asci cylindrical, attenuated near base, wall thickened at apex, $140\text{--}150 \times 11\text{--}13 \mu$; spores irregularly uniseriate, unicellular, biguttulate, oblong-elliptical, hyaline, $15\text{--}17.6 \times 5\text{--}6.5 \mu$; paraphyses filiform, septate, simple or branched near the base, pale brown, $2\text{--}2.5 \mu$ at apex.

Sclerotiiis applanatis, ellipticis vel elongatis, nigro-brunneis, in caulibus immersis, intus albidis, 3–7 mm. longis, 1–3 mm. latis, 1 mm. crassis; conidiis $13\text{--}17 \times 5\text{--}7.5 \mu$ in sclerotiiis cultis; apotheciis rufo-brunneis, primitus cyathiformibus, margine incurvato, denique patelliformibus, plerumque 3–7 mm., interdum 1 cm. diam., disco griseo-brunneo; stipite nigro, versus basim inflato, 0.5–1 cm. longo, 0.5–1 mm. diam.; ascis cylindricis, base attenuatis, apice incrassatis, $140\text{--}150 \times 11\text{--}13 \mu$; sporis irregulariter uniseriatis, simplicibus, oblongo-ellipticis, hyalinis, biguttulatis, $15\text{--}17.6 \times 5\text{--}6.5 \mu$; paraphysibus filiformibus, septatis, simplicibus vel ad basim ramosis, dilute brunneis, apice $2\text{--}2.5 \mu$ crassis.

On *Veratrum californicum* Durand, 390 (type) June 20, on the south shore of Mesa Lakes Reservoir, around pools of cold spring water; 392 (sclerotia) same data.

The sclerotia were noticed frequently on old stems but the perfect stage was seldom found and then under only the most ideal conditions.

A species of *Botrytis* with spores $13\text{--}17 \times 5\text{--}7.5 \mu$ developed on sclerotia that were placed in damp sand.

3. *Sclerotinia coloradensis* Cash & Davidson, sp. nov. (PLATE 38, FIG. 12.)

Sclerotia on stems and seed pods were thin, flat, elongated, sometimes confluent, black, white within, 0.2–3 cm. long, 2–5 mm. broad, 0.5 mm. thick, inconspicuous on weathered material. Apothecia one to several from each sclerotium, cup-shaped, becoming flat, pale brown, 2–3.5 mm. in diameter, hymenium pale brown, margin thin, inrolled when dry; stem brown, $4\text{--}7 \times 0.5$ mm.; asci cylindrical, blunt and thick walled at apex, short-pedicellate, $135\text{--}155 \times 7.5\text{--}9.5 \mu$; paraphyses filiform, septate, unbranched, 2.5μ at apex; spores unicellular, elliptical, hyaline, $10\text{--}12 \times 4\text{--}5 \mu$.

Sclerotiiis tenuibus, applanatis, elongatis, interdum confluentibus, nigris, intus albidis, 0.2–3 cm. longis, 2–5 mm. latis, 0.5 mm. crassis; apotheciis singulis vel pluribus ex quoque sclerotio, cyathiformibus vel patelliformibus, pallide brunneis, 2–3.5 mm. diam.; hymenio pallide brunneo, margine tenui, sicco incurvato; stipite brunneo, aequale, $4\text{--}7 \times 0.5$ mm.; ascis cylindricis, apice obtusatis et incrassatis, breviter pedicellatis, $135\text{--}155 \times 7.5\text{--}9.5 \mu$; paraphysibus filiformibus, septatis, non ramosis, apice 2.5μ crassis; sporis simplicibus, hyalinis, ellipticis, $10\text{--}12 \times 4\text{--}5 \mu$.

On *Pedicularis groenlandica* Retz., 517, July 3; 525 (type), July 7, on top of Grand Mesa.

On *Pedicularis bracteosa* Benth., 536 (sclerotia), July 8, at Mesa Lakes.

The type specimen was collected on boggy meadows not far from the road leading from Mesa Lakes to Alexander Lakes. The sclerotia, which occurred abundantly on all of the old stems, were first noticed on June 25, at which time none could be found in fruiting condition. Some of the sclerotia were taken to camp and an attempt made to induce fruiting, but an imperfect (*Botrytis*) stage was all that appeared. Eight days later a second trip was made to the top of Grand Mesa and the perfect stage found.

The thin, flattened sclerotia of this Colorado material are entirely unlike those of *Sclerotinia sclerotiorum*, the only species reported on Scrophulariaceae from North America, and the apothecia are much smaller.

4. *Sclerotinia foliicola* Cash & Davidson, sp. nov. (PLATE 37, FIGS. 8-9.)

Sclerotia surrounding mid-rib of over-wintered leaves, 1-4 cm. long by 0.5-1 mm. thick, the black cortex surrounding the mid-rib and extending through the leaf blade on each side, sclerotial cells intermixed with host tissue; apothecia at first cupulate, becoming almost flat at maturity, up to 1 cm. in diameter, grayish brown, hymenium paler, exterior slightly roughened, margin thin, inrolled when dry; stem brown, darker at base, 1-3 cm. \times 0.5-1 mm., rather stout when young, becoming slender at maturity; asci cylindrical, gradually attenuated at base, 120-140 \times 8-10 μ , apex truncate, pore blue with iodine; spores uniseriate, unicellular, elliptical, hyaline, 9-13 \times 5.5 μ ; paraphyses filiform, septate, unbranched, gradually enlarged to 3-4 μ at tip; exciple of hyaline prosenchyma becoming brownish and larger celled at cortex.

Sclerotiiis nigris, nervos foliorum vetustorum circumvallentibus, 1-4 cm. longis, 0.5-1 mm. crassis; apotheciis initio cupulatis, dein fere patelliformibus, usque 1 cm. diam., cinereo-brunneis, hymenio pallidiore, extus leniter rugulosis; margine tenui, sicco involuto; stipite brunneo, basim versus obscuriore, 1-3 cm. \times 0.5-1 mm., in juventute robustis, in maturitate tenuioribus; ascis cylindricis, ad basim paulatim attenuatis, 120-140 \times 8-10 μ , apice truncato, poro ope iodii coerulescente; sporis uniseriatis, simplicibus, ellipticis, hyalinis, 9-13 \times 5.5 μ ; paraphysibus filiformibus, septatis, non ramosis, apice paulatim 3-4 μ incrassatis; excipulo hyalino, prosenchymatico, cortice brunneo et magno-cellulari.

On *Salix* sp., 384 (type), June 20, Mesa Lakes; 422, June 24, Buzzard Creek; 758, July 22, Pinion Mesa (sclerotia and *Myrioconium*).

Sclerotinia rathenowiana Kirschst. (Rehm. Ascom. No. 1649) which was found on *Salix* twigs in Germany, has sclerotia emerging from beneath the bark, and differs in appearance and size from the Colorado species. The apothecia of *Ciboria filipes* Henn. on *Salix* leaves are much smaller (0.5–1 mm. diam.).

A species of *Myrioconium* found along the veins of the leaves in association with sclerotia is apparently the imperfect stage of this fungus.

5. *SCLEROTINIA GREGARIA* Dana. (PLATE 38, FIGS. 10–11.)

On *Amelanchier* (*alnifolia*?), 665, July 14, several miles down mountain from Mesa Lakes.

While examining a collection of *Ciboria Johnsonii* Ellis & Ev. on fruits and leaves of *Amelanchier*, it was noticed that several of the fruits contained lighter colored apothecia which grew from black sclerotia. Microscopical examinations showed that this was *Sclerotinia gregaria* Dana. The apothecia were clustered as described for this species.

The *Ciboria* occurred scattered through the thick damp leaf mold under *Amelanchier* and scrub oak timber.

6. *Sclerotinia fallax* (Sacc.?) Cash & Davidson, comb. nov.

? *Sclerotium fallax* Sacc. Nuovo Giorn. Bot. Ital. n. s. 23: 197, 1916.

Sclerotia on leaf 0.3–2 mm. long by 1 mm. wide and 0.5 mm. thick, falling out and leaving hole in leaf; apothecia small, patellate, 1–1.5 mm., pale brown, long-stipitate, stipe up to 1.4 cm. long; asci four-spored, cylindrical, apex rounded, attenuated at base, $55 \times 5\text{--}6 \mu$; spores uniseriate in upper half of ascus, unicellular, elliptical, narrower at lower end, $9\text{--}12 \times 3\text{--}4 \mu$; paraphyses filiform, septate, unbranched, 2μ thick.

Sclerotii 0.3–2 mm. longis, 1 mm. latis, 0.5 mm. crassis, ex foliis secedentibus; apotheciis parvis, patelliformibus, 1–1.5 mm. diam., pallide brunneis, longe stipitatis, stipite usque 1.4 cm. longo; ascis 4-sporis, cylindricis, apice rotundatis, base attenuatis, $55 \times 5\text{--}6 \mu$; sporis in parte superiore ascorum monostichis, simplicibus, ellipticis, apice inferiore angustioribus, $9\text{--}12 \times 3\text{--}4 \mu$; paraphysibus filiformibus, septatis, non ramosis, apice 2μ crassis.

On *Potentilla* sp., 476, July 1, Mesa Lakes.

At the time this specimen was collected it was almost impossible to determine the host on which it occurred. The apothecia were found for the most part on well rotted leaf mold close to a cold mountain stream. However one leaf which was lying very close to the water and which bore a number of apothecia was sufficiently preserved for a host determination.

The only similar organism that has been described on *Potentilla* or closely related hosts is *Sclerotium fallax* Sacc., on leaves of *Potentilla canadensis* from Spencertown, N. Y. (Saccardo 3, p. 197.) No material of the Saccardo species was available for comparison, but from the description it seems probable that it is the same. Some sclerotia in the Colorado specimen were larger than described for *S. fallax* and in this material they were amphigenous.

7. *Sclerotinia paludosa* Cash & Davidson, sp. nov. (PLATE 37, FIGS. 6-7.)

Sclerotia on leaves, often on edges, small, inconspicuous, 0.3-1 mm. in diameter, sometimes elongated up to 1.7 mm., black; apothecia brown, small, cupulate then becoming almost plane, 1.2-2 mm. broad, stipe 3-4 \times 0.3 mm.; asci cylindrical, attenuated at base, with short pedicel, truncate above, pore faintly blue with iodine, 150 \times 10-12 μ ; paraphyses numerous, filiform, septate, agglutinated and brown at tip, measuring 1-4 μ ; spores 1-2 seriate, one-celled, biguttulate, contents granular, 12-14 \times 5 μ .

Sclerotii foliicolis, parvis, 0.3-1 mm. diam., interdum usque 1.7 mm. longis, nigris; apotheciis brunneis, parvis, calyciformibus vel fere patelliformibus, 1.2-2 mm. diam.; stipite 3-4 \times 0.3 mm.; ascis cylindricis, ad basim attenuatis, breve pedicellatis, apice truncatis, poro dilute jodo coerulescente, 150 \times 10-12 μ ; paraphysibus numerosis, filiformibus, septatis, apice brunneis et coalescentibus, 1-4 μ diam.; sporis uniseriatis vel biseriatis, simplicibus, biguttulatis, intus granulosis, 12-14 \times 5 μ .

On overwintered leaves of *Carex exsiccata* Butler, 436 (type), June 25, on top of Grand Mesa; 443, 446, June 26, at Mesa Lakes; 459 (sclerotia), June 27, on top of Grand Mesa.

This *Sclerotinia* was found on top of Grand Mesa in marshy meadows the same day and about the same place as the following one on *Carex* seeds. The host however seemed to be a different and less common species of *Carex* and the organism was much more difficult to find than the following, *S. paludosa* always being found in very wet, soggy spots, while *S. utriculorum* occurred abundantly in broad expanses of damp meadows.

The sclerotia are very indistinct after formation of the apothecia, all of the fungus tissue seeming to go into the formation of the perfect stage.

This fungus does not agree with any described on Cyperaceae. In size of asci and spores it is close to *S. duriaeana* Tul., which is reported on *Carex* in Europe and North America, but sclerotia of the latter are in the interior of stems and much larger and more conspicuous. The apothecia of the latter are also very much larger.

This and the following species are doubtfully placed in the genus *Sclerotinia*, as the sclerotia are very indistinct. The sclerotia here described were collected in a drier locality and the apothecia, therefore, were found only where water stood almost continually, so it could not definitely be shown that they are identical.

8. *SCLEROTINIA UTRICULORUM* Boud. (PLATE 36, FIG. 5.)

On seeds of *Carex athrostachya* Olney, 435, June 25, on top of Grand Mesa; 443 and 474 at Mesa Lakes, June 26 and July 1, respectively.

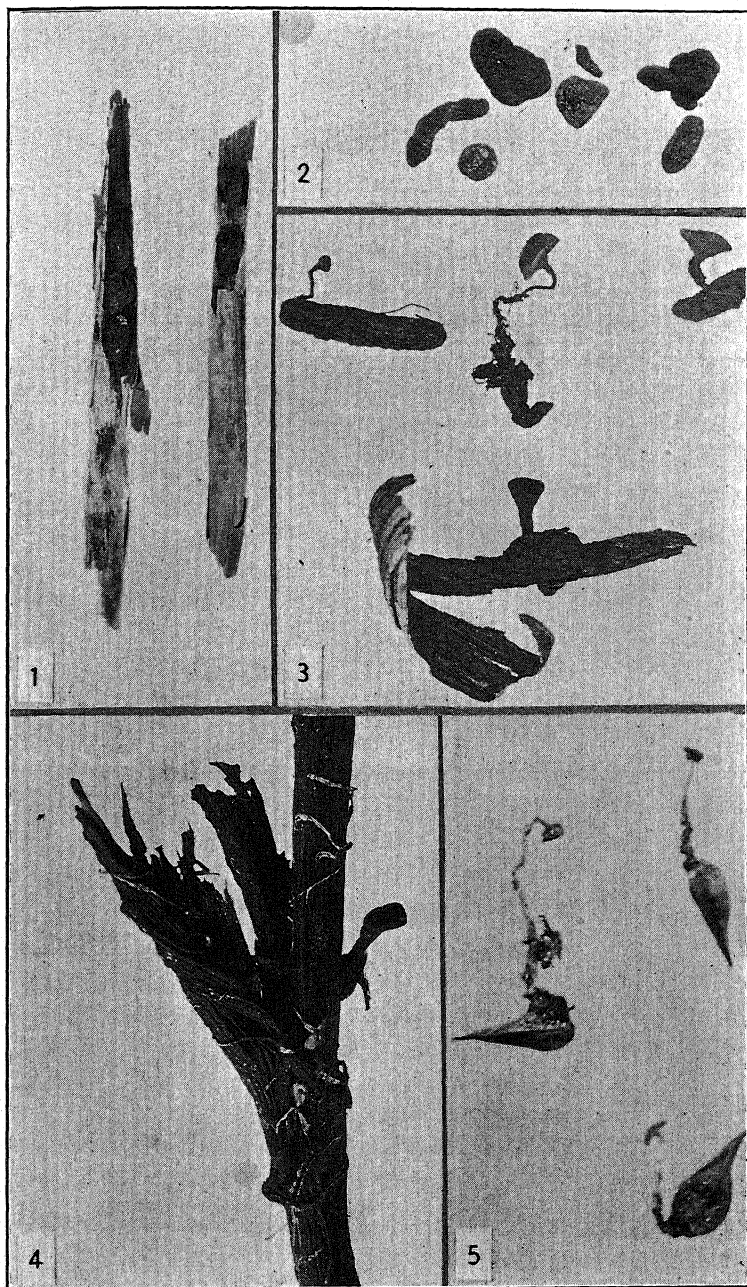
This attractive little species is not easily seen unless one is looking for it. However in this region it is widespread and very abundant, seeming to occur on almost all of the seeds in the particular plots examined.

It agrees very well with description and illustrations of *S. utriculorum* Boud. (1, p. 196, *pl.* 8, *fig.* 6) except that the asci and more irregularly shaped spores are smaller. The spores in this material are larger at one end and attenuated into a slightly curved elongation at the other.

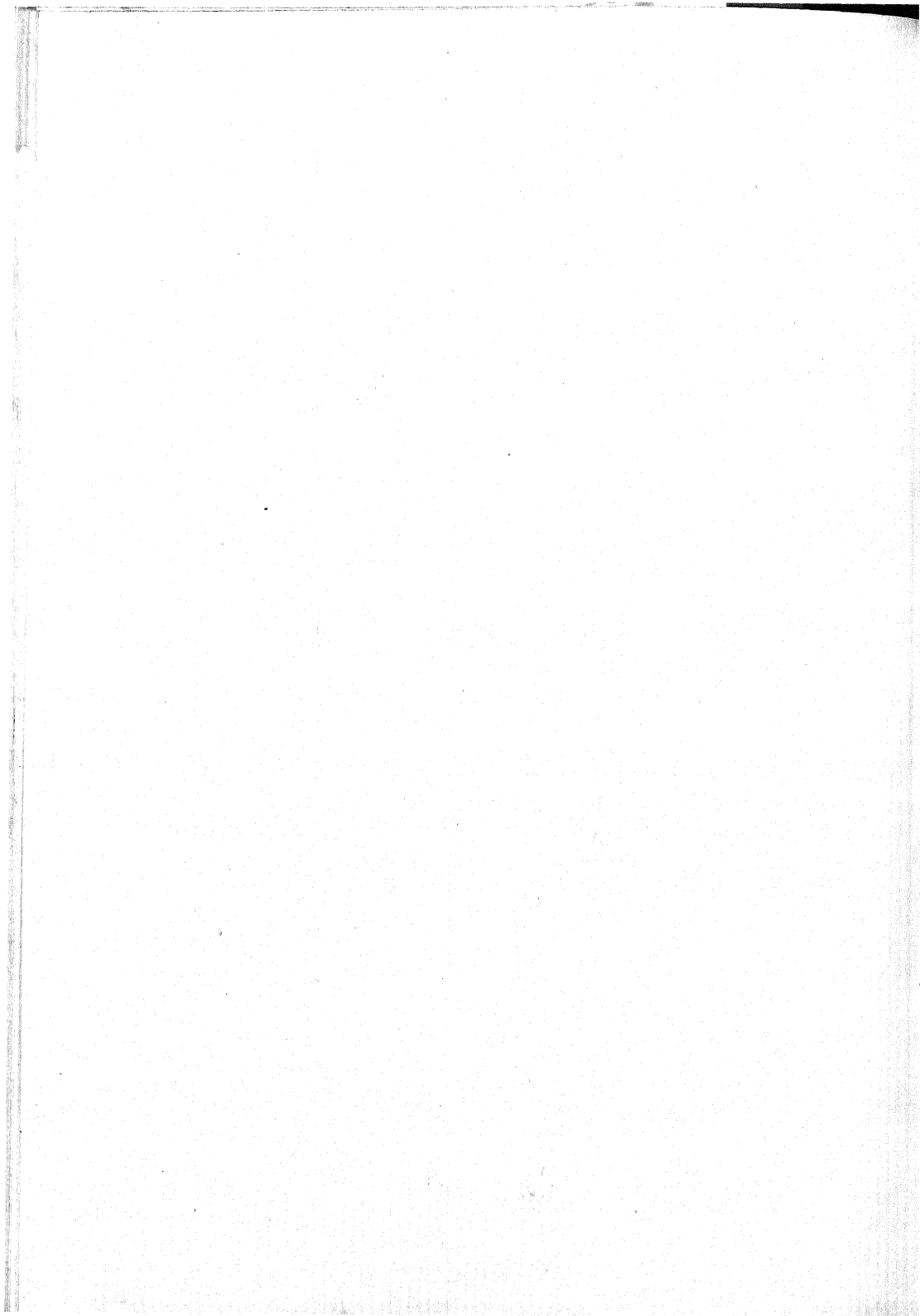
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WASHINGTON, D. C.

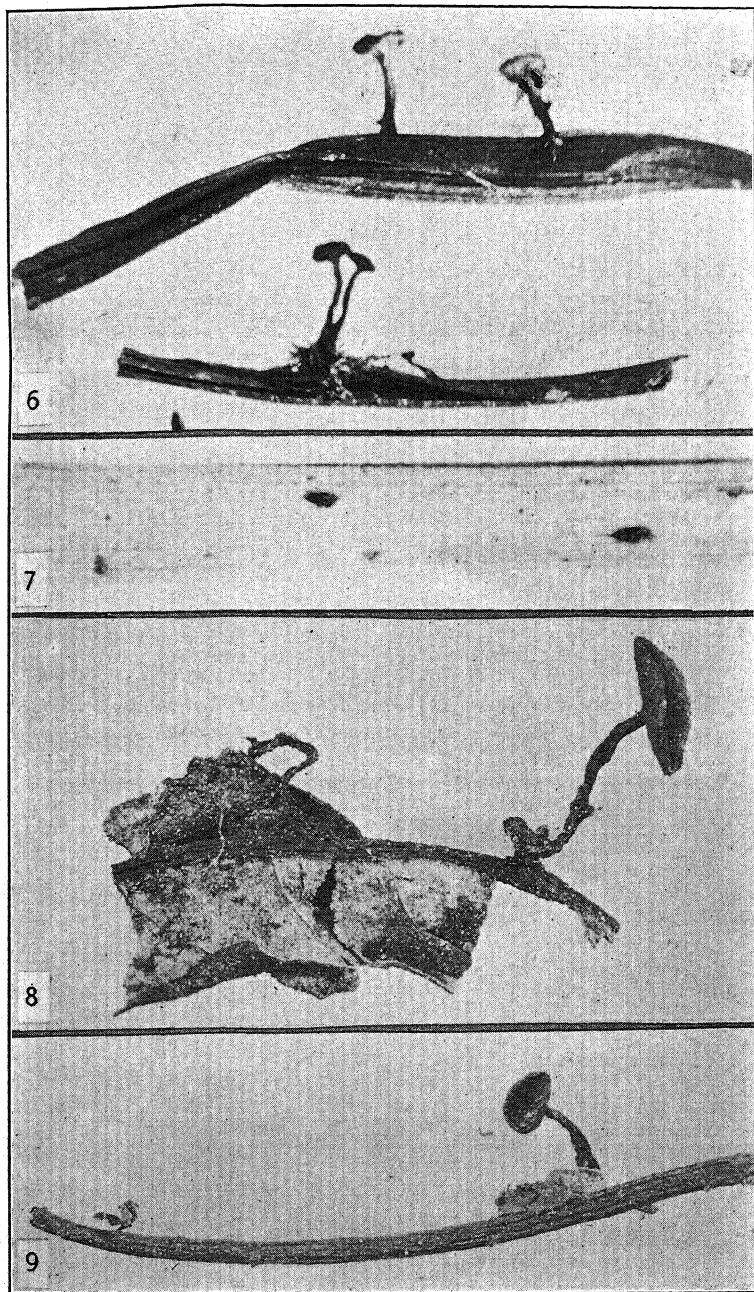
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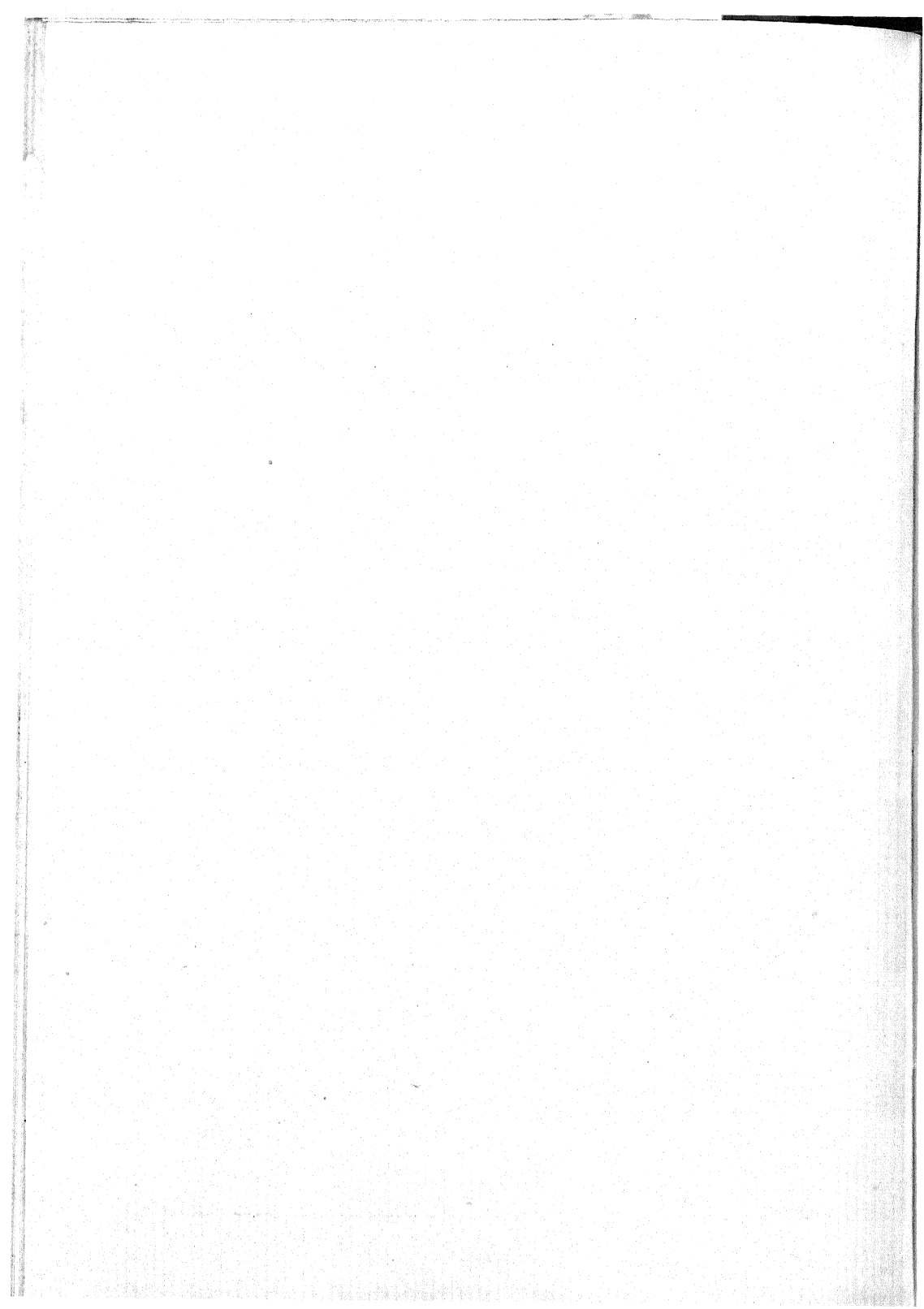


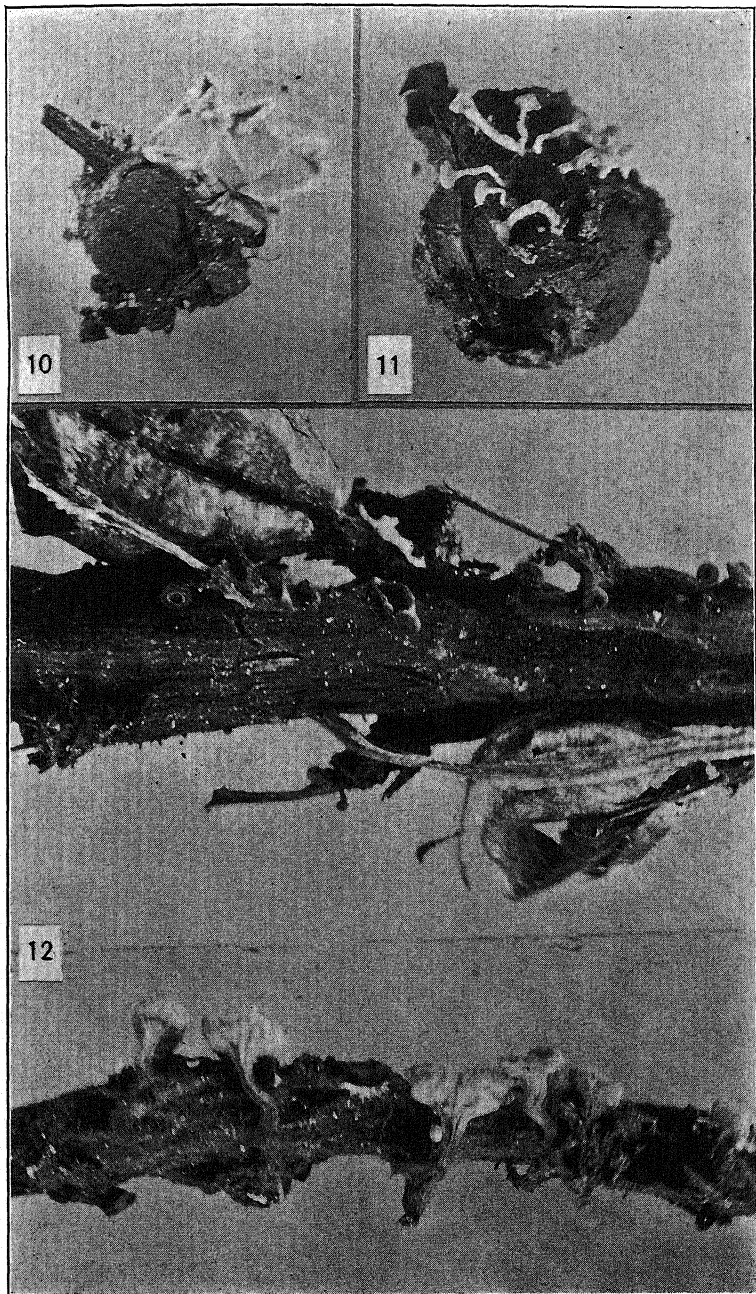
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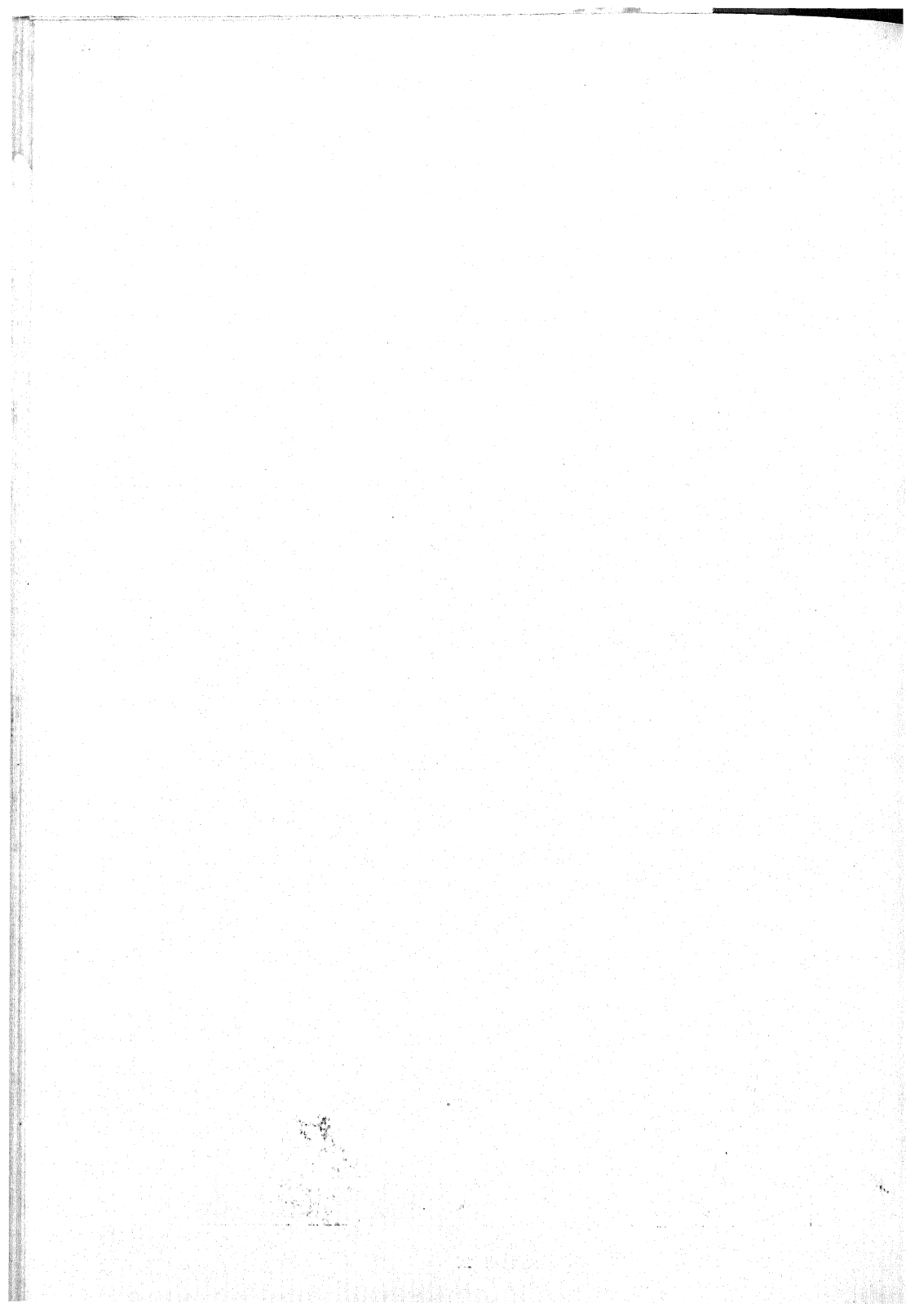


SCLEROTINIA





SCLEROTINIA



EXPLANATION OF PLATES

PLATE 36

Figs. 1-3, *Sclerotinia sclerotiorum* on *Aconitum*; 1, sclerotia in stems, $\times 1$; 2, sclerotia, $\times 1$; 3, apothecia growing from sclerotia, about $\times 2$; fig. 4, *Sclerotinia Veratri*. Apothecia on stem of *Veratrum californicum*, $\times 2$; fig. 5, *Sclerotinia utriculorum* Boud. Apothecia growing from *Carex* seed, $\times 5$.

PLATE 37

Figs. 6-7, *Sclerotinia paludosa* on *Carex*, $\times 5$; 6, apothecia on leaves; 7, sclerotia; figs. 8-9, *Sclerotinia foliicola* on *Salix*. Apothecia and sclerotia, $\times 5$.

PLATE 38

Figs. 10-11, *Sclerotinia gregaria*. Apothecia on fruit of *Amelanchier*, $\times 5$; fig. 12, *Sclerotinia coloradensis*. Apothecia and sclerotia on stems of *Pedicularis*, $\times 5$.

Photographs made by J. F. Brewer.

LIFE HISTORIES OF TRYBLIDIELLA SPECIES

C. L. SHEAR

(WITH 5 TEXT FIGURES)

The genus *Tryblidiella* was described by Saccardo (7) to include a group of Discomycetes having brown spores with two or more septa. This genus has been referred by some authors to the Hysteriaceae, but the plants are quite different in structure from typical members of that group. The species have rather large, thick, coriaceous apothecia which when fresh and moist are distinctly discoid, but when dry the margins of the apothecia roll inward covering most of the disk and giving the plants a superficial hysteroid appearance (FIG. 1, A AND B). The species of Saccardo were included by Ellis and Everhart (3) and some other authors under *Tryblidium*. The name, *Tryblidium*, as originally used by Rebentisch, 1805 (5), had as its type *T. calyciforme*, Rebent., which has hyaline muriform spores, and more or less regular apothecia with the margin irregularly torn. Later, Dufour, 1828 (2), referred to this genus a new species, *Tryblidium hysterinum*, which is quite different from Rebentisch's type, and belongs to an entirely different genus. Saccardo (8), however, in using the name, *Tryblidium*, took as the type Dufour's species which has one-septate brown spores, differing in this respect only from the genus *Tryblidiella*, which has two or more septate brown spores. Rehm has quite properly applied the name, *Tryblidium*, to the original type of Rebentisch, and included the one-septate spored species under *Tryblidiella*, which seems to be a natural arrangement. Rehm (6) published a revision of this and related genera in 1904, dividing the genus into two sections, *Eutryblidiella*, with spores one-septate, and *Rhydi-thysterium*, with spores three to five-septate.

No studies of the life history of this genus have heretofore been made so far as we know, nor any suggestion as to the existence of a pycnidial form. This is perhaps in part due to the fact that no pycnidia are usually found associated with apothecia of



FIG. 1. (A), Apothecia of *Tryblidiella hysterina* on *Ilex vomitoria*, dried specimen; (B), portion of the same specimen moistened, apothecia open; (C), *Tryblidiella rufula?* on Black Cherry, moistened, showing open apothecia. All $\times 2.6$; (D), section of pycnidia (*Diplodia*) from single ascospore culture of *T. rufula?* from *Rhus* grown on sterile grape shoots, $\times 130$. Photomicrographs by J. F. Brewer.

Tryblidiella. The few pycnidia we have found with them do not agree with the forms produced in cultures, but belong to *Physalospora*.

We first began our studies of these fungi in 1923. Apothecia of *Tryblidiella* (specimen No. 1559) which agree very well with the description of *T. Leprieuri* (Mont.) Sacc. were found on dead branches of tea plants kindly sent us by Mr. A. C. Tunstall, Mycologist, of the Indian Tea Association. Cultures were made from single ascospores from one of these which grew well on cornmeal agar, producing a growth very similar in appearance to that of species of *Physalospora*. Transfers made to cornmeal in flasks soon produced, much to our surprise, *Diplodia*-like pycnidia having smooth brown, mostly one-septate spores, $20-25 \times 9-11 \mu$ (FIG. 4, B, AND FIG. 5, B). Later, what was still more unexpected, apothecia with ascospores of *Tryblidiella* appeared in one of the flasks. These agreed with the original specimens from which the cultures were made, except that the ascospores apparently did not reach full size and maturity (FIG. 2, D). No microspores were observed in these cultures, but they might very easily have been overlooked.

Later on during various collecting expeditions in Florida and other southern states where species of this genus are common, specimens were collected on various hosts and single ascospore cultures were made as follows:

First, from a species which agrees well with the description of *T. rufula* (Spreng.) Sacc. found on dead *Rhus* sp. at Monticello, Fla., No. 3917. These cultures first produced micropycnidia with hyaline subglobose microspores $2-3 \mu$ in diameter (FIG. 3, A). A little later pycnidia of a *Diplodia*-like form, having broadly striate, mostly one-septate, brown spores, $16-19 \times 10-12 \mu$ developed (FIG. 4, A). These spores resemble those of *D. Theobromae*, in everything but size (FIG. 5, A).

A little later, single ascospore cultures were made from apothecia on black cherry, *Prunus serotina*, No. 3916, which seemed to belong, according to their general morphological characters and spore measurements, to the same species of *Tryblidiella* as that found on *Rhus* in the same locality. These specimens were at first referred to *T. rufula* (Spreng.) Sacc., but since ascospores

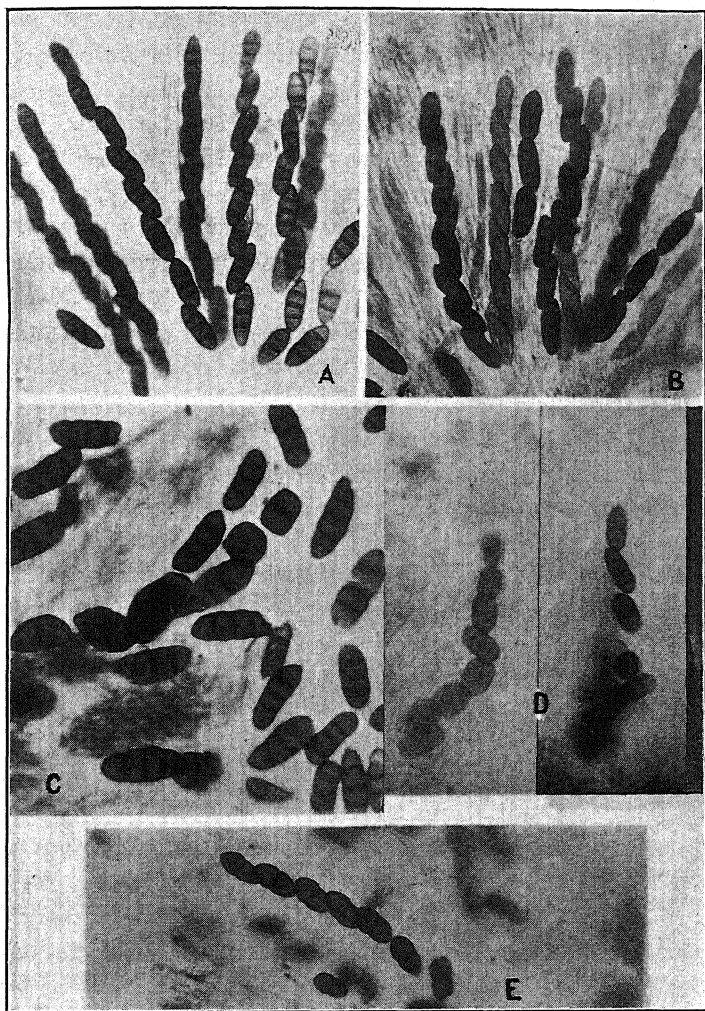


FIG. 2. (A), asci and ascospores of *Tryblidiella rufula*? No. 3917 from *Rhus*; (B), asci and ascospores of *T. rufula*? No. 3916 from Black Cherry; (C), ascospores of *T. Leprieuri* No. 1559 from tea, India; (D), asci and ascospores from pure culture of *T. Leprieuri* from tea, on cornmeal; (E), ascus and ascospore of *T. hysterina* No. 5813 from *Ilex*.. All $\times 283$.

from the two hosts give different *Diplodia*-like species it remains for the present doubtful which, if either, is true *T. rufula*. These cultures had the same general appearance as the preceding and produced both pycnidia with hyaline subglobose microspores (FIG. 3, B), and later *Diplodia*-like pycnidia and spores. These spores were brown, mostly one-septate, $15-18 \times 6-9 \mu$, and scarcely distinguishable from spores of *Diplodia Mori*, according to Dr. N. E. Stevens, who kindly compared them (FIG. 5, c). Single ascospore cultures were also made from a specimen identified as *T. rufula*, collected by Dr. G. W. Carver on *Melia* at Tuskegee, Ala., our No. 3906. These cultures produced micro- and macropycnospores agreeing with those obtained in culture from the specimens on black cherry.

Though the pycnospores are distinctly different in the cultures of *T. rufula*? from *Rhus* and from cherry (see measurements and figures) the apothecia and ascospores from which they came do not seem to be distinguishable, and the species can only be separated at present on the basis of their pycnidial character, as is the case in some species of *Physalospora*. These results suggest that it may be necessary to know the pycnidial forms of our species of *Tryblidiella* in order to determine them with certainty.

Later, a collection was made on *Ilex vomitoria*, on Smith's Island, N. C., No. 5813, which agreed with the descriptions of *Tryblidiella hysterina* (Duf.) comb. nov. (*T. elevata* (Pers.) Rehm¹).

¹ The use of this name by Rehm and others is an excellent example of the perpetuation of an error by continuous copying of a mistake or misinterpretation without verification of citations. The name *Hysterium elevatum* Pers. first appeared in print as a synonym of *Tryblidium hysterinum* in Dufour's article, l.c., with the citation "Myc. Eur. Tab. 1, fig. 4 (Mala.)." A thorough examination of Persoon's work cited shows that by some error of omission there is no description or mention of any such species in the text and no reference to his figure. The name therefore dates from Dufour's use of it as a synonym l.c. The way the name *elevatum* originated seems to be indicated by Dufour's notes and observations, following his description. He says "Obs. Je ne saurais douter du synonyme cité de Persoon, quoique la description de cet auteur n'accompagne pas la figure inexacte qu'il en a donnée, parce que je lui ai communiqué dans le temps des échantillons de mon espèce." This indicates apparently that Persoon's illustration was made from a specimen sent him by Dufour, as he states in a preceding paragraph that he collected abundant specimens of the fungus in 1814 and Persoon's book was not published until 1822. The natural inference would be that Persoon gave him the name *Hysterium elevatum* in a letter and had an illustration made of the specimen but omitted the description and name. Persoon's name *elevatum* has therefore no priority over *hysterinum*.

This is the species with one-septate ascospores (FIG. 2, E). Single ascospore cultures from this material produced *Diplodia*-like pycnidia only. No micropycnidia with hyaline spores, such as were found in the two other cases mentioned were seen, but these might easily have been overlooked as they were found in the next series. The *Diplodia*-like spores were very variable in shape and size, ranging from $15-23 \times 9-12 \mu$, average about $20 \times 10 \mu$ (FIG. 5, D). They resemble in shape and character *Diplodia Alni* Fuckel, whose perfect stage is unknown. Ascospore cultures have also recently been made from *T. hysterina* on *Ilex vomitoria* from Alabama, No. 3907. These produced micro- and macro-pycnidia and spores agreeing rather closely in size, shape and general character with those obtained in culture from the same host collected on Smith's Island.

The *Diplodia*-like pycnidia produced from ascospores from three of these collections and hosts show differences in size, shape and markings of the pycnospores which would, according to present ideas of classification, place them in different species. Pycnospores from tea have the same general size and shape as those of *D. natalensis* or *D. Theobromae*, but they do not show the longitudinal striae characteristic of that species. Of the other species with which it has been compared, it seems closest to *D. vulgaris* Lév., whose perfect stage is not known. The cultures from apothecia on *Rhus*, as already stated, resemble *D. Theobromae* in everything but size. *D. Theobromae* according to our present interpretation is the same as *D. natalensis*, which has been proven to be the pycnidial stage of *Physalospora*.

In all of the cultures made from *Tryblidiella*, the general character and appearance of the *Diplodia*-like pycnidia and spores are the same as in those made from species of *Physalospora*. It seems rather remarkable at first thought that the pycnidial forms of such widely separated genera as *Tryblidiella* and *Physalospora* should be so similar as to be referred to the same form genus, *Diplodia*. It is probable, however, that when we come to compare more thoroughly all of the characters of these pycnidial forms throughout their development, sufficient differences may be found to separate generically the species having such widely different perfect stages.

Pycnidial forms of *Physalospora* are variable in many respects especially as to the formation of stromata. Some produce micropycnospores and frequently so-called paraphyses are found.

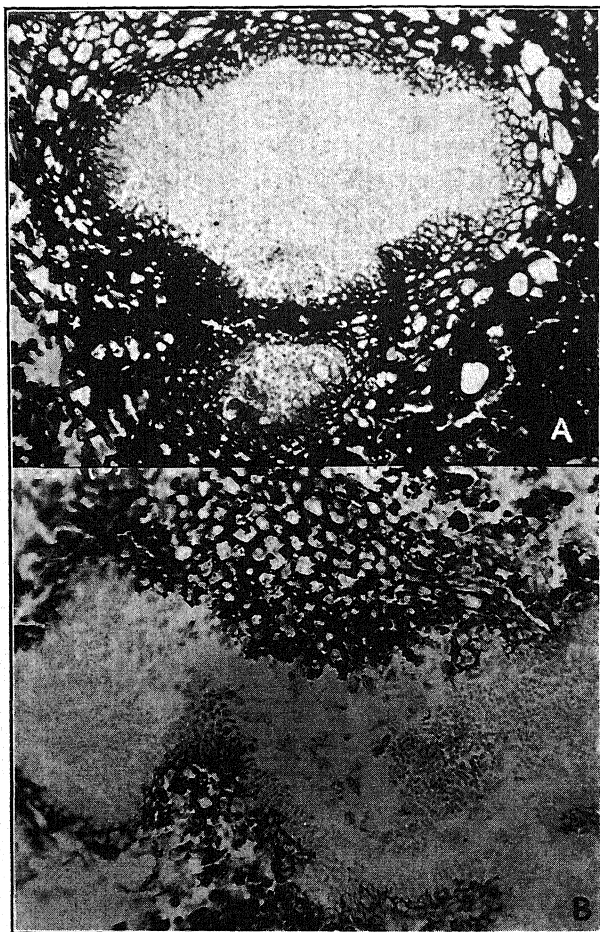


FIG. 3. (A), section of micropycnidium and spores from a single ascospore culture of *T. rufula?* from *Rhus*, on cornmeal; (B), micropycnidium and spores from a single ascospore culture of *T. rufula?* from Black Cherry on cornmeal. Both $\times 130$.

Thus far we have not seen these so-called paraphyses in the pycnidia produced by *Tryblidiella*.

If one should accept the method of segregation of genera adopted by Petrak and Sydow (4) for this group of pycnidial

forms those considered here might easily be referred to different form genera; but until we know more about the value of the criteria used, the range of variability of the characters and the life histories of the fungi, it is doubtful whether such efforts would be worth while. In this connection it is interesting to compare figure 1, D, with figure 4, A and B, noting the difference in the character of the pycnidial walls in the first, which were grown on sterile grape twigs, and the second grown on cornmeal.

We had at one time hoped that the conidial forms of the Ascomycetes when definitely connected with their perfect stages would provide a means of segregating some of the genera with more certainty. In that respect the results of our study of *Tryblidiella* are rather disappointing. Many mycologists, however, who have not made life history studies in this group may have accepted the view of Fuckel, Tulasne, Saccardo and others, who were apparently not at all disturbed by the heterogenous pleomorphism indicated by the association of pycnidial forms of the same genus with very diverse ascogenous genera to which they believed they were genetically related. Saccardo, for example, in his *Sylloge Fungorum* gives *Diplodia* as the pycnidial form of species of *Cucurbitaria*, *Massaria*, *Othia*, *Melanomma*, *Pleospora*, *Thyridaria* and *Gibberidia*. There are probably other genera also given, as we have not attempted to make a complete list.

In the case of *Thyridaria*, Bancroft (1) states that he has obtained *Diplodia* in pure cultures from ascospores and Tunstall (10) has confirmed this work. In the other genera mentioned the connection has not been demonstrated by pure cultures so far as known, except in the case of *Cucurbitaria*, one species of which we have just proven has *Diplodia*-like pycnidia. This will be discussed in a later paper.

In the past the taxonomy of the Ascomycetes has been based generally on the belief that the ascocarps possess the distinctive morphological characters by which they can be segregated into genera and species and the conidial forms, even when positively known, have been regarded as having little or no generic significance.

It may possibly develop that the various conidial and pycnidial forms found have no more taxonomic significance than that of the

vegetative forms of reproduction which occur in other groups of plants, such as bulbs, bulbils, tubers, gemmae or sclerotia. However, the greater complexity and differentiation of parts of many

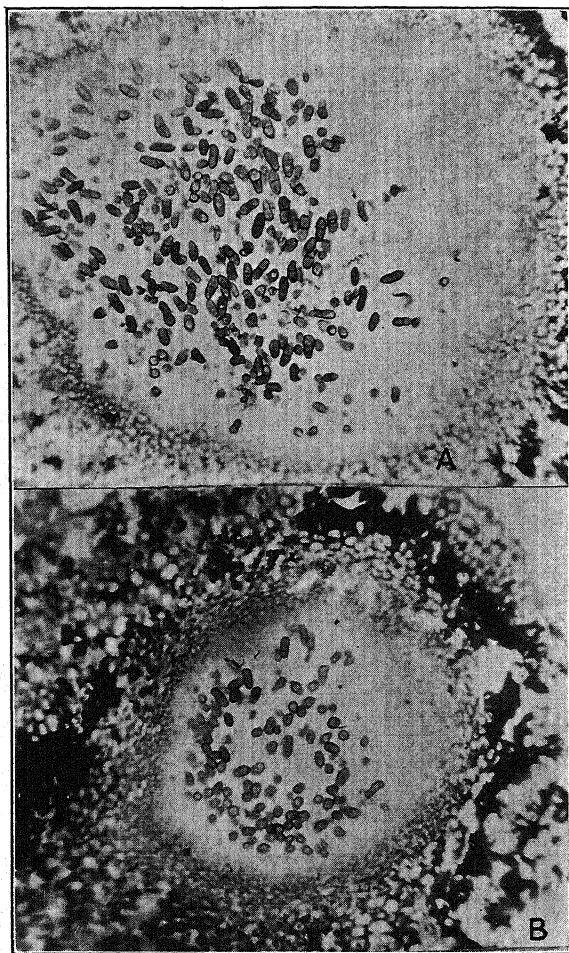


FIG. 4. (A), section of macropycnidium (*Diplodia*) from a single ascospore culture of *T. rufula*? from *Rhus*, on cornmeal; (B), section of macropycnidium (*Diplodia*) from a single ascospore culture of *T. Leprieuri*, from tea, on cornmeal. Both $\times 130$.

pycnidial forms suggests that they may have greater taxonomic significance than the vegetative organs mentioned. See Shear (9) for further discussion.

The above studies, however, show that at least such highly developed forms as those usually referred to *Diplodia* may occur in such widely separated genera as *Tryblidiella*, *Physalospora* and

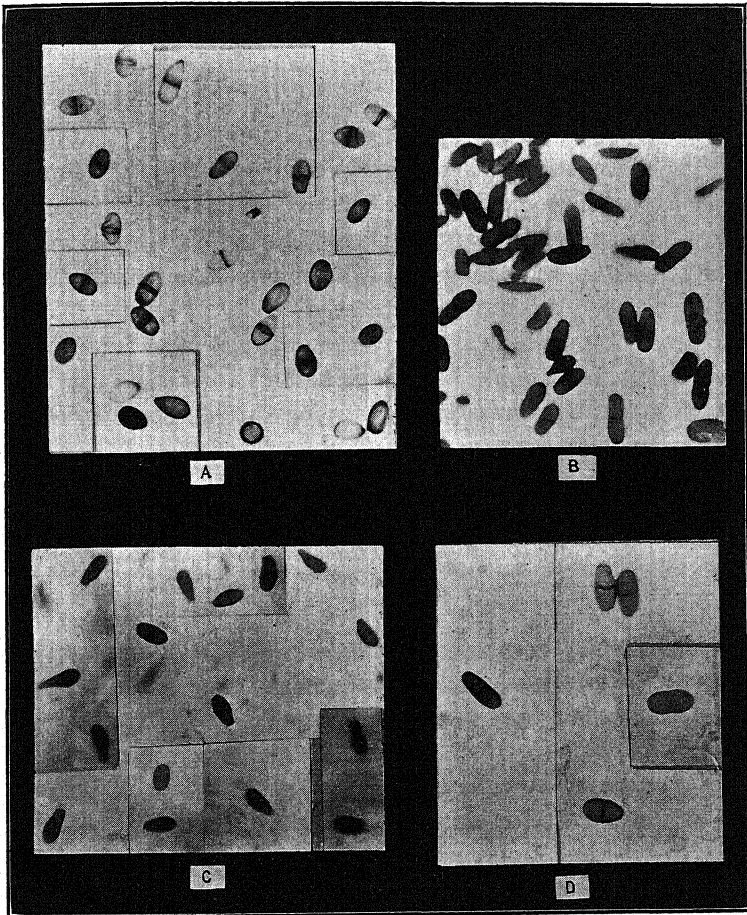


FIG. 5. (A), pycnospores (*Diplodia*) from single ascospore culture of *T. rufula?* from *Rhus*; (B), pycnospores (*Diplodia*) from single ascospore culture of *T. Leprieuri*, from tea; (C), pycnospores (*Diplodia*) from single ascospore culture of *T. rufula?* from Black Cherry; (D), pycnospores (*Diplodia*) of single ascospore culture of *T. hysterina*, from *Ilex*. All $\times 283$.

Cucurbitaria, and that parallelism of this sort evidently occurs in other cases.

No general conclusions can be drawn from the facts at present

available. Each genus and species behaves according to its own peculiar nature and what its life history may be cannot be predicted with assurance from our knowledge of what appear to be closely related genera and species. For example, one species of *Mycosphaerella* may be connected with *Phoma* or *Phyllosticta*, another with *Ramularia*, the next with *Cercospora* and then come species with *Septoria* and *Cylindrosporium*. Are there other species with still different deuterioforms?

Our present knowledge of the "Nebenfructen" of the fungi is sufficient to show that no so-called natural arrangement of the groups is possible and that they should be classified for the present solely from the standpoint of practical convenience and ease of identification. When the life histories of the ascomycetes are as completely known as in the rusts, the names of most form genera may be discarded as has been done in the Uredineae.

Although full information concerning the life histories of the pleomorphic fungi apparently will not give us an easy key to their phylogeny, or taxonomy, it will certainly reveal more of the marvelous versatility of Mother Nature and the wonderful diversity and complexity of her creations.

SUMMARY

Pure cultures from single ascospores of *Tryblidiella Leprieuri* from tea give *Diplodia*-like macropycnidia. Similar cultures of *T. rufula* (Spreng.) Sacc.? from *Rhus* give micropycnidia with hyaline sub-globose spores, and *Diplodia*-like macropycnidia. Cultures from similar material referred to the same species on black cherry gave similar micro- and *Diplodia*-like macropycnidia which are different from the preceding. Similar cultures from specimens on *Melia* from Alabama produce micro- and macropycnidia agreeing with those from the specimens on black cherry. Single ascospore cultures of *T. hysterina* (Duf.) Shear from *Ilex vomitoria* from two localities gave micropycnidia and *Diplodia*-like macropycnidia resembling *Diplodia Alni*.

The *Diplodia*-like forms obtained appear similar to those obtained from ascospore cultures from *Physalospora* and raises the question as to what dependence can be placed upon the pycnidial

or conidial stages in determining the limits of genera and species of Ascomycetes.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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THE GENERA OF HYDNACEAE

L. W. MILLER

The family Hydnaceae, as ordinarily defined, is held to include all autobasidiomycetes in which the hymenium is borne upon downward directed spines, warts or folds. As thus defined most of the genera and species are clearly separated from those of related families. Intermediate forms do occur, however, grading into the Polyporaceae on the one hand and the Thelephoraceae on the other. This fact has influenced various attempts to make the boundaries of the family more distinct. Since the time of Fries, our knowledge of the internal structure and reproduction of these fungi has been greatly increased and it has been necessary to make many changes in taxonomic treatment. The lack of agreement in current literature as to what constitutes the most precise or convenient classification is due largely to our still meager knowledge of the natural relationships among these fungi. The family has been insufficiently studied and, therefore, any scheme of classification applied to it must be regarded as tentative.

The removal of certain genera and species apparently related to the Polyporaceae but included in the Hydnaceae of Fries and his predecessors was suggested first in 1821 by the work of S. F. Gray.¹ He erected the Sistotremideae on *Sistotrema*, *Cerrena* and *Xylodon*, and characterized the new family as "thallus leather-like; hymenium at first meandering, porous, becoming toothed; teeth lamellar, torn." In 1879 Karsten transferred *Irpex*, *Sistotrema* and *Phlebia* to the Polyporaceae. Patouillard in 1900 included *Phlebia*, *Hydnochaete*, *Lopharia*, *Sistotrema* and species of *Irpex* among the polypores. Weir and Hubert (1918) comment on the daedaloid character of the young sporophore of *Echinodontium*.

¹ It is not known whether S. F. Gray, A Natural Arrangement of British Plants, Vol. 1. 1821, was published before or after Fries, Systema Mycologicum, Vol. 1. 1821. I have been informed by Dr. J. H. Barnhart that it is generally regarded as post-Friesian. This position is taken by A. B. Seymour as stated on page 9 of the preface to his Host Index of the Fungi of North America. 1929.

The toothed configuration of the hymenium in *Hydnochaete*, *Sistotrema*, *Irpex* and *Echinodontium* is typically preceded by a more or less poroid configuration. This is made evident by comparing the young, growing marginal portion of a fructification with the older central portion. The flattened and irregular teeth of the older parts of a fructification are often connected by ridges which may be regarded as the remains of the pores from which the teeth were derived. The development of teeth by the breaking up of the pores is not uncommon in other genera of the Polyporaceae. It occurs in many species of *Daedalea*, *Poria*, *Polyporus* and *Polystictus*. It would seem therefore that *Hydnochaete*, *Sistotrema*, *Irpex* and *Echinodontium* should be placed in the Polyporaceae.

Phlebia and *Lopharia* are more closely related to *Merulius* than to any genus of the Hydnaceae; they differ from *Merulius* chiefly in having the hymenial folds or ridges less anastomosed. *Phlebia* also shows close relationship to *Corticium* and thus offers a possible connecting link between the Thelephoraceae and the Polyporaceae through *Corticium* and *Merulius*. The disposition of this genus in the Merulieae of the Polyporaceae seems to be in accord with its natural relationship.

The Phylacteriaceae, erected by Patouillard in 1900 on *Caldesiella*, *Sarcodon* (i.e. *Hydnum*, as here defined) and *Calodon* of the Hydnaceae and *Phylacteria* and *Tomentella* of the Thelephoraceae, and characterized by its dark trama and dark, roughened spores, is recognized by such recent European writers as Bourdot and Galzin (1927) and Cejp (1928). Research has not yet shown that the hymenial configuration stressed by earlier mycologists should be subordinated to the characters upon which the Phylacteriaceae is segregated. Such hyphae and spore characters in the basidiomycetes have generally been regarded as of generic significance only.

The group of resupinate hydnums has been least satisfactorily divided. *Odontia* was restricted by Fries in 1838 to those species chiefly characterized by crested or penicillate warts. Today the presence of cystidia is emphasized, which is a better and more exact interpretation of the character which Fries observed. *Grandinia* Fries is generally applied to the forms which have a

granulose hymenium, as was probably originally intended by Fries. In order that *Grandinia* may be separated clearly from *Odontia* it must be restricted to species lacking cystidia. Although *Grandinia* Fries and *Odontia* Fries do not seem to be natural genera their use is justified because of their wide recognition and because of the fairly well defined and convenient division of resupinates which each represents.

In addition to *Odontia*, *Grandinia* and several other well marked resupinate genera there still remains a number of species which have fairly conspicuous spines, no cystidia and a texture varying from floccose to ceraceous. These forms are obviously included in the older genus *Odontia* of Persoon or *Hydnum* tribe *Resupinatus* of Fries. Quélet (1878) raised this group to generic ranking and applied to it the name *Hydnum*. The rules of nomenclature do not permit such a use of *Hydnum*, however. *Acia* Karsten was erected on approximately the same group but the name must be rejected as a homonym, having been applied to a genus of the Rosaceae in 1791. Recent authors either have regarded these species as a subdivision of the genus *Hydnum* or have attempted to distribute them among other recognized genera. The nearest approach to their recognition as a genus is found in *Acia* of Rea, Bourdot and Galzin and other European writers. However, these restrict *Acia* to adnate, ceraceous forms only. In order that the division of the resupinate species into genera may be complete, I am proposing the name *Oxydontia* to represent this group, defining it so as to include both adnate and separable forms which may vary in texture from floccose to ceraceous.

The principal criteria upon which the Friesian system of classifying the hymenomycetes is based, seem yet to be the most natural and workable. Many changes have necessarily been made, as is to be expected. Such a genus as *Tremellodon* would obviously be removed and placed in the Tremellales upon the discovery of cruciately divided basidia. On equally valid grounds I believe the removal of *Sistotrema*, *Irpex*, *Hydnochaete*, *Echinodontium*, *Phlebia* and *Lopharia* is justified. Our present knowledge of the Hydnaceae seems to warrant the recognition of the following genera:—*Caldesiella*, *Asterodon*, *Grandinia*, *Odontia*,

Oxydontia, *Radulum*, *Mucronella*, *Gloiodon*, *Steccherinum*, *Auriscalpium*, *Hericium*, *Dentinum*, *Hydnodon*, *Hydnum*, *Calodon* and probably *Grammothele*.

The Hydnaceae in this somewhat restricted sense includes only those autobasidiomycetes in which the hymenium is borne upon downward directed spines, teeth or warts, which have not arisen by the breaking up of pores.

KEY TO THE GENERA OF THE HYDNACEAE

1. Fructification with a porose-reticulate hymenial surface covered over with minute warts. *Grammothele*.
1. Fructification with distinct warts or teeth, never poroid. (2)
 2. Trama dark; spores roughened, subhyaline to dark, usually brown. (3)
 2. Trama pale; spores smooth or sometimes echinulate, hyaline, sometimes slightly colored. (5)
3. Resupinate, soft, floccose; growing on wood. *Caldesiella*.
3. Stipitate; fleshy or coriaceous; growing on the ground. (4)
 4. Fleshy. *Hydnum*.
 4. Fibrous, tough. *Calodon*.
5. Teeth arising directly from the substratum. *Mucronella*.
5. Teeth developed on a distinct hymenophore. (6)
 6. Resupinate or reflexed; spines borne on tough, branching processes which are partially submerged in a brownish tomentum. *Gloiodon*.
 6. Resupinate, reflexed or stipitate; teeth or spines not borne on tough, branching processes. (7)
7. Fructification resupinate, thin, floccose, crustaceous, ceraceous, or subcoriaceous. (8)
7. Reflexed to stipitate, rarely resupinate; fleshy to coriaceous. (12)
 8. Ceraceous; teeth thick or occasionally slender, obtuse, usually deformed and irregularly scattered. *Radulum*.
 8. Texture variable; teeth hemispherical to cylindrical or subulate, varying from short, fragile, inconspicuous warts to long, conspicuous teeth or spines. (9)
9. Cystidia or setae present. (10)
9. Cystidia or setae absent. (11)
 10. Trama dark, floccose; spores smooth; stellate setae present. *Asterodon*.
 10. Trama pale, texture variable; spores smooth or occasionally echinulate; cystidia present. *Odontia*.
11. Warts short, hemispherical, cylindrical, or subulate and fragile. *Grandinia*.
11. Teeth or spines conspicuous, long, slender, usually terete. *Oxydontia*.
 12. Fleshy; growing on the ground. (13)
 12. Fleshy or coriaceous; growing on a woody substratum. (14)
13. Mesopodous; spores smooth. *Dentinum*.

13. Pileus irregular, with deformed stipe; spores minutely echinulate. *Hydnodon.*
14. Fructification richly branched or pulvinate, soft, fleshy; gloeocystidia usually present; spores spherical or subspherical. *Hericium.*
14. Fructification reflexed to laterally stipitate, rarely resupinate; subfleshy and fibrous or coriaceous; spores variable. (15)
15. Cap coriaceous, with a long, laterally attached stipe; spores slightly roughened. *Auriscalpium.*
15. Reflexed to obscurely laterally stipitate (occasionally resupinate in *S. ochraceum* and *S. lacticolor*), subfleshy to coriaceous; spores smooth. *Steccherinum.*

GRAMMOTHELE Berk. & Curt. Jour. Linn. Soc. 10: 327. 1869.
Includes *Gloiothele* Bres. Ann. Myc. 18: 44. 1920.

Fructification resupinate, effused, crustaceous; hymenial surface porose-reticulate, minutely warted throughout; with or without gloeocystidia. Growing on wood in the tropics.

Grammothele is chiefly characterized by its porose-reticulate hymenial surface which is more or less completely covered over by minute warts. Since the hymenium extends over the warts the genus has been regarded as belonging to the Hydnaceae rather than the Polyporaceae. *Gloiothele* Bres. was erected on *Poria lamellosa* P. Henn. and differs from *Grammothele*, according to Bresadola, only in the possession of gloeocystidia. *Grammothele lineata* Berk. and Curt. is the type of *Grammothele*.

CALDESIELLA Sacc., *Michelia* 1: 7. 1877. *Odontia* Pat. Hy-mén. Europ. 149. 1887. *Acia* subgen. *Aciella* Karsten, Finl. Basid. 362. 1889. *Amaurodon* Schroeter, Krypt.-Fl. Schles. 3: 461. 1889. *Phaeodon* sect. *Hydnopsis* Schroeter, Krypt.-Fl. Schles. 3: 458. 1889.

Fructification resupinate, soft, floccose, dark; spines soft, conical; cystidia none; spores colored, spherical or subspherical, roughened. Growing on wood.

This genus seems closely related to *Hypochnus* of the Thelephoraceae from which it is distinguished by the presence of distinct spines. It may readily be separated from *Asterodon* and *Hydnochaete* by its roughened spores and lack of setae. The mycelial and spore characters suggest more or less close relationship with the two stipitate genera, *Hydnum* and *Calodon*. These

three genera were combined in the single genus *Phaeodon* by Schroeter in 1889. The dark mycelium and dark roughened spores were considered sufficiently distinct by Patouillard in 1900 to justify removing *Caldesiella*, *Sarcodon* (*Hydnum*) and *Calodon* from the Hydnaceae and placing them with *Phylacteria* and *Tomentella* of the Thelephoraceae in the new family Phylacteriaceae.

Caldesiella was erected in 1877 on the single species *C. italica* Sacc. and placed in the gasteromycetes. In 1881 Saccardo transferred *Hydnum ferruginosum* Fries to *Caldesiella* and correctly listed it with the hymenomycetes. Unfortunately *C. italica* grades into *Hypochnus* and is therefore not as typical a hydnum as is *C. ferruginosus* (Fries) Sacc., nor is it as common. According to our interpretation of the rules *C. italica*, however, must be regarded as the type.

ASTERODON Pat. Bull. Soc. Myc. Fr. 10: 129. 1894. *Hydnochaete* Peck, Ann. Rep. N. Y. State Mus. 50: 113. 1897, non Bres. *Hydnochaetella* Sacc. Tab. Com. Gen. Fung. 11. 1898.

Resupinate, effused, floccose-tomentose, dry; spines subulate; setae dark, simple or stellate; spores subhyaline, smooth. Growing on wood.

Asterodon resembles *Caldesiella* in the colored, floccose, resupinate fructification but may readily be distinguished by the presence of setae and the smooth, subhyaline spores. It differs from *Hydnochaete* in having stellate setae and in its dryer and more floccose texture. It corresponds to *Asterostroma* of the Thelephoraceae. *A. ferruginosum* Pat. is the type.

GRANDINIA Fries, Epicr. 527. 1838.

Fructification resupinate, thin, membranaceous, soft crustaceous or ceraceous; warts or spines small, generally fragile, hemispherical to cylindrical or subulate; cystidia or cystidia-like structures lacking; spores hyaline, smooth or roughened. Growing on wood.

The distinction between *Grandinia* and related resupinate forms is not always sharp. In fact, the genus is discarded by Quélet (Fl. Myc. Fr. 432. 1888) on the ground that it is not an

autonomous group but merely represents young stages of *Odontia* or forms of *Corticium*. Killermann (Eng. and Pr. 160. 1928.) considers it a poor genus for the same reason. *Grandinia* does not differ essentially from *Odontia* in texture and often not in the nature and character of the spines. Its species usually are more fragile and possess shorter spines, characters which, however, are not diagnostic. The spines of *Grandinia raduloides* (Karsten) Bourdot & Galzin, for example, are larger than those of *Odontia hydnoides* (Cooke & Mass.) V. Hohn. In such cases the presence or absence of cystidia alone determines the generic reference. The hymenium is generally borne over the entire surface of the hemispherical warts and the cylindrical spines with obtuse apices but is often interrupted by the sterile hyphae at the apices of subulate spines. Species in which these sterile hyphae project prominently either singly or in bundles are referred to *Odontia*. *Grandinia* differs from *Corticium* in the possession of spines or warts but this distinction is not always sharp. A young fructification of a species of *Grandinia* may occasionally be quite smooth or *Corticium*-like, or a species of *Corticium* may possess a colliculose or slightly granular hymenial surface suggesting true warts.

Grandinia was erected on seven species, of which the first mentioned by Fries, *G. polycocca* Fries, is designated the type by Banker (1902). Clements and Shear (1931) cite *G. granulosa* Fries as the type.

ODONTIA Pers. *emend.* Fries, Epicr. 528. 1838. Includes *Kneiffia* Fries, Epicr. 529. 1838. (*Kneiffiella* Underwood, Bull. Torrey Club. 24: 205. 1897. *Neokneiffia* Sacc. Tab. Com. Gen. Fung. 11. 1898. *Pycnodon* Underwood, Bull. Torrey Club 25: 431. 1898.) *Dacryobolus* Fries, Summa Veg. Scand. 404. 1849. *Odontina* Pat. Hymén. Europ. 147. 1887. *Grandiniella* Karsten, Hedwigia 34: 8. 1895. *Ethei-rodon* Banker, Bull. Torrey Club 29: 441. 1902. *Hydnopsis* Rea, Brit. Basid. 650. 1922.

Resupinate, membranaceous, floccose, crustaceous or rarely ceraceous, sometimes pruinose; spines variable, conical to subulate or cylindrical, typically divided or penicillate; cystidia always present; spores variable. Growing on wood.

The presence of cystidia is diagnostic for this genus. These structures may occur scattered in the hymenium or be restricted to the apex of the spine where they project singly or in loose to compact bundles. Forms in which the projecting fascicles of cystidia may be little more than unspecialized hyphal ends, as in *Odontia Pruni* Lasch. and *Odontia cristulata* Fries, represent a transition to the condition in certain species of *Grandinia*, for example, *G. farinacea* Fries, in which the spines are terminated by sterile but non-projecting hyphae. *Odontia* is separated from *Oxydontia* and *Grandinia* by the presence of cystidia and from *Peniophora* of the Thelephoraceae by the warty configuration of the hymenium. Resupinate specimens of *Steccherinum ochraceum* and *S. laticolor* may sometimes wrongly be referred to *Odontia*.

Odontia was established by Persoon in 1794 on two resupinate species. Later in 1801 and 1825, he reduced this genus to the rank of a subgenus of *Hydnum* and apparently included all the resupinate hydroid species known to him. Persoon's division *Odontia* of *Hydnum* in this sense was synonymous with the tribe *Resupinatus* of the same genus as treated by Fries in the *Systema Mycologicum*. S. F. Gray (1821) was the first post-Friesian writer again to recognize *Odontia* Pers. as a distinct genus. A number of attempts have been made to divide this rather large group of resupinate species into smaller and more natural or convenient genera. In 1838 Fries erected *Grandinia* and *Odontia* on certain of these species, the remaining species were retained in the tribe *Resupinatus* of *Hydnum*. The multifid or penicillate character of the crests of the spines noted by Fries in the original description of *Odontia* is apparently due largely to the projecting cystidia. Cystidia therefore have become the distinguishing character of the genus in the modern sense rather than the multifid or penicillate character in gross appearance. Many species have since been transferred to *Odontia* Fries even though the cystidia are inconspicuous and visible only under the microscope. *Odontia* Fries in this sense corresponds to *Peniophora* of the Thelephoraceae. *Odontia fimbriata* Pers. is to be regarded as the type.

Kneiffia was also established by Fries in 1838 as a new genus of the Hydnaceae, based on *Thelephora setigera* Fries. It seems that conspicuous cystidia again serve as the diagnostic character.

The two genera were not adequately distinguished in the original descriptions nor do the characters of the species included seem to justify such a separation. I am, therefore, following Patouillard (1900) in relegating *Kneiffia* to synonymy. *K. setigera* Fries is known in Europe as *Peniophora setigera* (Fries) Bres. Its reference to *Peniophora* does not seem to be justified in view of the fact that the hymenial surface usually appears papillate.

Oxydontia gen. nov. (ὀξύς, sharp; ὀδούς, a tooth.) *Hydnum* Quélet, in Cooke & Quélet, Clav. Hymen. 200. 1878.
Acia Karsten, Medd. Soc. Faun. Fl. Fenn. 5: 28. 1879.

Fructification resupinate, effused, adnate or separable, floccose, fleshy or ceraceous; spines typically long, subulate; cystidia absent; spores variable. Growing on wood.

Pileus resupinatus, effusus, adnatus vel secedens, floccosus, carnosus vel ceraceus, aculeis longis, subulatis, cystidiis nullis. Hab. ad ligna.

Type: *Hydnum setosum* Pers.

Oxydontia is separated from *Odontia* by its lack of cystidia and from *Grandinia* by the longer, subulate and conspicuous teeth. These distinctions are admittedly artificial but have the advantage of being convenient and fairly distinct. Since all gradations occur between sterile basidia and typical cystidia certain species will obviously need to be placed arbitrarily in *Odontia* or in *Oxydontia*. The same is true of species possessing teeth intermediate between the typical dome-shaped or fragile warts of *Grandinia* and the elongated, subulate teeth of *Oxydontia*.

Species collected in Iowa which I include in this genus are *O. himantia* (Schw.), *O. alboviride* (Morg.), *O. fragilissima* (Berk. & Curt.), *O. stenodon* (Pers.), *O. setosa* (Pers.), *O. macrodon* (Fries). *Oxydontia* is essentially synonymous with *Hydnum* Quélet (1878) and *Acia* Karsten (1881) but neither name is tenable. *Hydnum* is applied to a group of stipitate forms and *Acia* was applied to a genus of the Rosaceae by Schreber in 1791. *Oxydontia* includes a greater range of species than the *Acia* of Rea and Bourdot and Galzin. Forms that have floccose or fleshy as well as separable fructifications are added. For example, *O. fragilissima* (Berk & Curt.) is ceraceous and a good "*Acia*" except that it is separable; *O. himantia* (Schw.)

or *O. alboviride* (Morg.) may have waxy, *Acia*-like teeth but a floccose subiculum.

RADULUM Fries, Elenchus Fung. 1: 148. 1828. *Phaeoradulum* Pat. Tax. Hymén. 69. 1900. *Tylodon* Banker, Bull. Torrey Club 29: 440. 1902.

Fructification resupinate, rarely reflexed, fleshy-ceraceous; teeth blunt, generally coarse, deformed, irregularly scattered or confluent. Growing on wood.

The species of *Radulum* are exceedingly variable in the expression of external characters. Microscopic structures must be noted. The spore characters prove helpful for the few species which have been found in Iowa. Members of this genus show some relationship with certain of the fleshy or waxy species of *Corticium* which exhibit at times a colliculose hymenium or widely and irregularly scattered humps, for example, *C. tuberculatum* Karsten, *C. cremicolor* Berk. & Curt. and *C. hydnans* (Schw.) Burt. The exact dividing line between *Radulum* and *Corticium* is, therefore, not always sharp. I believe it best to refer to *Corticium* those forms in which humps sometimes occur irregularly or appear merely as slightly raised areas on the hymenial surface.

Banker (1902) designates the species represented by *Radulum pendulum* Fries in the Elenchus Fungorum as the type of this genus. This species is regarded as a form of *Corticium subcostatum* (Karst.) by Bourdot and Galzin. Clements and Shear (1931) cite *Radulum orbiculare* Fries as the type. The latter species is widely distributed and a typical representative of the genus.

MUCRONELLA Fries, Hym. Europ. 629. 1874. *Mucronia* Fries, Summa Veg. Scand. 329. 1849.

Subiculum absent or consisting of a floccose, fugacious mycelium; spines subulate, entire. Growing on wood and bark.

This genus is quite distinct. It resembles a small *Clavaria* or *Pterula* in general appearance but differs fundamentally in its pendent spines. It is best considered a resupinate hydnum in which the subiculum has almost or quite disappeared. The type species is *Hydnum calvum* A. & S. The name *Mucronia* is

untenable, having been applied to a genus of the Polygonaceae in 1837.

GLOIODON Karsten *emend.* Banker, Mycologia 2: 10. 1910.
Karsten, Medd. Soc. Faun. Fl. Fenn. 5: 28. 1879, in part.
Sclerodon Karsten, Finl. Basid. 360. 1889. *Leaia* Banker,
Mem. Torrey Club 12: 175. 1906.

Fructification resupinate to pileate and laterally sessile, tough, fibrous, dark, consisting of branched processes in a coarse tomentum; teeth slender, acute; spores faintly roughened, short elliptical, hyaline. Growing on wood.

The branched processes in the pileus constitute the outstanding character of the genus and readily separate it from other genera of the Hydnaceae. Its texture, color and spore characters suggest relationship with *Auriscalpium* from which it is sharply marked off, however, by the branching processes and the resupinate or sessile fructification.

Karsten based *Gloiodon* on *Hydnum strigosum* Schw. and two other species. Banker seems first to have emphasized the branching processes in the fructification of the type as a diagnostic generic character. Patouillard, Bresadola, Rea and others who do not recognize *Gloiodon* associate its species generally with those of *Steccherinum* as treated in this paper. The slightly colored hyphae, the roughened spores and the dividing processes contrast sharply, however, with the equivalent characters of species of *Steccherinum*.

STECCHERINUM S. F. Gray, Nat. Arr. Brit. Pl. 1: 651. 1821.
Pleurodon Quélet, in Cooke and Quélet, Clav. Hymen. 198.
1878, in part. *Creolophus* Karsten, Medd. Soc. Faun. Fl.
Fenn. 5: 27. 1879. *Climacodon* Karsten, Rev. Myc. 3: 20.
1881. *Leptodon* Quélet, Ench. Fung. 191. 1886, *emend.*
Pat. Hymén. Europe. 146. 1887. *Mycoleptodon* Pat.
Tax. Hymén. 116. 1900.

Pileus laterally substipitate or sessile, reflexed or rarely entirely resupinate, usually tough and fibrous, sometimes subfleshy; spines terete or flattened; cystidia common; spores minute, smooth, ovoid to oblong, white in mass. Growing on wood.

Steccherinum is related to *Gloiodon* and to *Auriscalpium*, but may readily be separated from the former by the hyaline hyphae,

smooth spores and the absence of the solid processes ramifying through the pileus, and from the latter by a generally lighter colored fructification and the absence of a distinct stipe.

Several attempts have been made to divide the species represented in *Steccherinum* into more homogeneous groups. Karsten proposed the name *Creolophus* apparently to include the sub-fleshy species and *Climacodon* the leathery members but the distinction was not clearly made. Banker suggested a similar division in 1913. Such a distinction between fleshy and leathery members of the genus seems inadvisable since all, including *S. pulcherrimum*, perhaps regarded as the most "fleshy," have a more or less fibrous texture. The type is *Hydnum ochraceum* Pers.

AURISCALPIUM S. F. Gray, Nat. Arr. Brit. Pl. 1: 650. 1821.

Karsten, Medd. Soc. Faun. Fl. Fenn. 5: 27. 1879. *Pleurodon* Quélet, in Cooke and Quélet, Clav. Hymen. 198. 1878, *emend.* Karsten, Rev. Myc. 9: 19. 1881. *Leptodon* Quélet, Ench. Fung. 191. 1886, in part.

Pileus entire or lobed, laterally stipitate, leathery; spines slender, subulate; cystidia if present little differentiated; spores hyaline, small. Growing usually on cones of conifers.

This genus is distinguished from *Steccherinum* by the lateral stipe. Intermediate species occur, however, in which the pileus may be laterally short stipitate as in *S. adustum* and *S. reniforme*.

As treated by Quélet (1878) *Pleurodon* was equivalent to the tribes *Pleuropus* and *Apus* of the genus *Hydnum* of Fries. Later (1886 and 1888) Quélet seems to have substituted the name *Leptodon* for essentially the same group. He did not recognize the generic distinction between the forms with lateral stipes and those with resupinate, reflexed or laterally sessile pilei. In this broad sense the genus included a number of species of *Steccherinum*. In 1879 Karsten erected a new genus *Auriscalpium* on *Hydnum auriscalpium* L. and two other species, which is antedated by *Auriscalpium* S. F. Gray. Most of the remaining species which Quélet included in *Pleurodon*, Karsten distributed in two or three other new genera. In 1881 Karsten seems to have substituted Quélet's name *Pleurodon* for his own *Auriscalpium*.

The name *Pleurodon* in this restricted sense is in common usage in Europe. *A. vulgare* S. F. Gray (*Hydnum auriscalpium* L.) is the type of *Auriscalpium*.

HERICIUM Pers. ex. S. F. Gray, Nat. Arr. Brit. Pl. 1: 652. 1821.

Medusina Chev. Fl. Gen. Env. Paris. 278. 1826. *Dryodon*

Quélet, in Cooke and Quélet, Clav. Hymen. 198. 1878.

Friesites Karsten, Medd. Soc. Faun. Fl. Fenn. 5: 27. 1879.

Manina Scop. ex. Banker, Mycologia 4: 275. 1912.

Fructification fleshy or subfleshy, nodulose, tuberculiform or branched; spines mostly subulate, long and pendent; gloecystidia usually present; spores spherical or subspherical, guttulate. Growing on wood.

Hericium Pers. was considered by Fries in the Systema Mycologicum as synonymous with his tribe *Merisma* of the genus *Hydnum*. In 1825 Fries recognized *Hericium* as a genus but in a different and questionable sense (Banker, Mycologia 4: 275. 1912.). Regardless of Fries's treatment of *Hericium* the name may still be used since S. F. Gray in 1821 clearly defined the genus and published with it the same single species *H. coralloides* which appeared in the original description of *Hericium* by Persoon (1794).

DENTINUM S. F. Gray, Nat. Arr. Brit. Pl. 1: 397. 1821. *Ty-*

rodon Karsten, Rev. Myc. 3: 19. 1881. *Hydnum* L. ex Fr.

Syst. Myc. 1: 397. 1821, *emend.* Pat. Hymén. Europ. 145.

1887. *Hypothele* Paulet ex Banker, Torreya 4: 113. 1904.

Pileus with a central stipe, fleshy, white or pale; spines subulate; spores white in mass. subspherical. Growing on the ground.

Dentinum is distinguished from related genera by its pale color and its hyaline, smooth spores.

This genus is commonly known today by the name *Hydnum*. The earlier name *Dentinum* S. F. Gray is here restored in accordance with the rules of the international code. *Dentinum* was founded on *H. repandum* (type) and *H. rufescens*.

HYDNODON Banker, Mycologia 5: 297. 1913.

Pileus with a deformed stipe, irregular, expanded, fleshy, thin, drying hard and brittle, orange to red; teeth short, stout,

deformed, reddish; spores minute, echinulate, whitish or faintly colored. Growing on the ground in the tropics. North Carolina.

Hydnodon is based on *Hydnum thelephorum* Lév. which is chiefly characterized by the thin, fleshy substance, deformed stipe, short, stout and deformed teeth and the whitish, echinulate spores. The description and a specimen from Jamaica which I saw at The New York Botanical Garden suggest relationship with species of *Dentinum*.

HYDNUM L. *emend.* S. F. Gray, Nat. Arr. Brit. Pl. 1: 650. 1821.

Fries, Syst. Myc. 1: 397. 1821, in part. *Sarcodon* Quélet, in Cooke and Quélet, Clav. Hymen. 195. 1878. *emend.* Karsten, Rev. Myc. 3: 20. 1881.

Pileus with a central stipe, fleshy, generally dark colored; spines subulate, simple; spores small, subspherical, angular or echinulate, brown. Growing on the ground.

This genus is separated from *Calodon* by its fleshy texture and from *Dentinum* by its dark color and roughened spores. Fries, in the Systema Mycologicum, referred a very large and heterogeneous group, comprising all species with awl-shaped spines, to the genus *Hydnum*. As thus defined *Hydnum* included a large majority of the species of the family, ranging from the simple resupinate forms to the more specialized stipitate forms. It is obviously desirable to separate such a large and heterogeneous group into smaller and more homogeneous genera. The various attempts to do this have resulted in a comparatively large number of proposed segregates and generic names. The application of the name *Hydnum* has varied considerably.

In 1821 S. F. Gray erected a number of new genera in the Hydnaceae and retained the name *Hydnum* for certain of the fleshy, mesopodous species, of which *Hydnum imbricatum* only was mentioned. Since the fleshy mesopodous *Hydnum repandum* was transferred to his new genus *Dentinum*, it is apparent that *Hydnum* as used by Gray is identical with *Sarcodon* Quélet. *emend.* Karsten in common usage today. Quélet (1878) and Karsten (1881) applied the name *Hydnum* to the large number of resupinate species which at that time had not been transferred to other recognized resupinate genera, such as *Odontia* and *Grandinia*. Patouillard (1887) was the first to restrict the name *Hydnum*,

as now commonly used, to the fleshy, mesopodous, white-spored forms growing on the ground. In 1900 Patouillard enlarged the boundaries of the genus to include also *Hericium* Pers. and *Dryodon* Quél. Banker, Bourdot and Galzin and Cejp follow Patouillard's earlier conception. Gäumann and Dodge state that *Hydnum repandum* is the type. Clements and Shear, however, indicate *H. imbricatum* as the type. *Hydnum* as used by Coker (1919) is antedated by *Sarcodon* Quél. Hennings and Killermann (old and new edition of Engler & Prantl) and Rea retain in large part the Friesian conception of the genus.

Hydnum repandum is the nomenclatorial type of *Hydnum* according to common usage. That species, however, must be referred to *Dentinum* and therefore cannot serve as the type of *Hydnum*. According to the International rules it seems that *Hydnum imbricatum* L. must be regarded as the type. In some respects it is unfortunate that this species should be regarded as the type of the type genus since neither the dark, tuberculate spores nor the dark hyphae of the fructification are as typical of the family as a whole as are the hyaline, smooth spores and pale hyphae of *Hydnum (Dentinum) repandum*, which is also usually the commoner species. Nevertheless, if the two species are to be recognized as representing distinct genera, as seems to the writer amply justified, the rules seem clearly to necessitate citing *imbricatum* as the type of the genus *Hydnum*.

CALODON Quél. in Cooke & Quélet, Clav. Hymen. 196. 1878.

Hydnullum Karsten, Medd. Soc. Faun. Fl. Fenn. 5: 27.

1879. *Phellodon* Karsten, Medd. Soc. Faun. Fl. Fenn. 6: 15. 1881.

Pileus with a central stipe, fibrous, tough, sometimes woody, dark colored; spores subspherical, coarsely angular or echinulate, brown or subhyaline. Growing on the ground.

Calodon differs from both *Hydnum* and *Dentinum* by its tough, fibrous texture. Karsten in 1881 divided this genus into the white toothed forms to which he gave the name *Phellodon* and the dark toothed forms to which he assigned Quélet's name *Calodon* rather than his own name *Hydnullum*. This distinction was maintained by Banker and tentatively by Coker; both, however, applied the name *Hydnullum* to the group with dark spines.

Banker (1906) described the spores of *Hydnellum* as "colored, coarsely tuberculate," and the spores of *Phellodon* as "white or hyaline, usually echinulate." I have examined a number of species belonging to each of these proposed genera and feel that the differences are not sufficiently distinct. There seems to be a gradual transition from the darker forms with coarse tuberculate spores to the less dark with echinulate, pale spores. *Hydnellum* and *Phellodon* do not seem to me to be two distinct groups with a few intermediate forms but rather a single group which varies somewhat in color and in the roughened character of the spore. *Hydnum suaveolens* Scop. is regarded as the type.

The present study was pursued in the mycological laboratories of the State University of Iowa under the direction of Prof. G. W. Martin.

DEPARTMENT OF BOTANY
STATE UNIVERSITY OF IOWA
IOWA CITY, IOWA

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NEW GENERA AND SPECIES OF LICHENS FROM THE HERBARIUM OF BRUCE FINK I¹

JOYCE HEDRICK

The specimens upon which these genera and species are based were collected within the United States. Most of the specimens were collected by Dr. Bruce Fink or were sent to him for identification by other collectors. In a few cases the specimens, named but apparently undescribed, have come from the herbaria of earlier investigators. Wherever possible the names have been attributed to the original investigators, but the descriptions were prepared by Dr. Fink. All of the specimens were studied by him in the preparation of the manuscript for "The Lichen Flora of the United States" which has not yet been published.

Since there is no certainty when his manuscript will be published, it seems best that these descriptions should appear in a separate paper so that they may be available to other students of the group. They have been copied from his manuscript with very little change. The accompanying notes have been made from his notations on the specimen packet or herbarium sheet.

The type specimens were deposited in the Fink Herbarium which is now a part of the Herbarium of the University of Michigan. The writer wishes to thank Professor E. B. Mains for helpful suggestions and criticism in preparing the manuscript, and Professor H. H. Bartlett and Miss M. E. Anthony for correcting the Latin descriptions.

1. *Verrucaria nigrescentoidea* Fink, sp. nov.

Thallus tenuissimus vel tenuis, late expansus, levis vel leviter confragosus, demum areolatus, glauco-fuscus vel obscure niger; perithecia minuta vel parva, 0.1-0.3 mm. lata, dimidiata, numerosa, plus minusve immersa, subhemisphaerica, obscure nigra; sporae 8, decolores, ellipsoideae, non septatae, 12-15 \times 5-6 μ , inconditae.

Thallus very thin to thin, widespread, smooth to slightly rough, becoming areolate, grayish-brown to dull black; perithecia minute

¹ Papers from the Department of Botany and the Herbarium of the University of Michigan, No. 412.

to small, 0.1–0.3 mm. across, dimidiate, numerous, more or less immersed, the superficial portion subhemispherical, dull black; hypothecium and hymenium hyaline; paraphyses gelatinizing and disappearing; asci clavate; spores 8, hyaline, ellipsoid, non-septate, $12-15 \times 5-6 \mu$, irregularly arranged.

The algal host is *Pleurococcus*.

On rock, Auburndale, Minnesota, collected by Bruce Fink September 8, 1902 (type), Fink Herb. No. 15,532.

Very similar to *V. nigrescens* Pers., but with smaller spores. *V. nigrescens* has spores which are $15-28 \times 7-11 \mu$, so that these are less both in length and width.

2. *Verrucaria subsuperficialis* Fink, sp. nov.

Thallus tenuis vel sat crassus, levis vel leviter confragosus, olivaceus, e parvis areolis insularibus dispersis in hypothallo diffuso constans; perithecia minuta, 0.17–0.2 mm. lata, olivaceo-nigra, dispersa vel contigua, superne sphaeroidea vel subconoidea, inferne plana, haud vel partim in thallo immersa, integra aut dimidiata; sporae 8, decolores, ovoideo-oblongae, non septatae, $7-9 \times 4-5 \mu$.

Thallus thin to somewhat thick, smooth to slightly rough, olivaceous, occurring fully developed with perithecia in small areas, these areas interspersed in about equally extensive very thin areas (hypothallus) showing the lichen hyphae and the algal host cells, both the thick and the thin areas remaining firm when wet; perithecia minute, 0.17–0.2 mm. across, olivaceous-black, sphaeroidal or subconical above and flattened below, scattered to closely placed, entirely above the substratum and readily removed with the thallus, the basal third immersed in the latter, complete with perithecial wall thin below, or sometimes dimidiate and centrally open below; hypothecium and hymenium hyaline; paraphyses gelatinizing early and invisible at maturity of spores; asci clavate; spores 8, hyaline, ovoid-oblong, non-septate, $7-9 \times 4-5 \mu$.

The algal host is *Pleurococcus*, but the thecial algae are apparently *Trentepohlia*.

On a littoral quartz pebble, Long Beach Bay, Orient, Long Island, New York, collected by Roy Latham in 1925 (type).

Species of *Verrucaria* of marine and brackish habitat are few and always interesting; and other lichens of similar habitats are likewise not numerous. Similar to *V. margacea* Wahl. and *V. aethiobola* Wahl. as to thallus but the thick and thin areas are more pronounced here. Distinguished from the two above and

from most of the other species of *Verrucaria* of the United States by the small spores which are not more than $10\ \mu$ in length.

3. *Verrucaria silicola* Fink, sp. nov.

Thallus tenuis vel mediocriter crassus, levis vel confragosus, demum rimosus, interdum minute granulosus, obscure glaucus vel niger; perithecia minuta vel parva, 0.15–0.4 mm. lata, dispersa aut plus minusve aggregata, immersa vel partim superficialia, dimidiata, supra subhemisphaerica aut subconoidea, obscure nigra, ostiolo minuto, saepe vix conspicuo; sporae 8, decolores, oblongo-ellipsoideae, non septatae, $18\text{--}22 \times 8\text{--}9\ \mu$, inconditae.

Thallus thin to moderately thick, smooth to rough, becoming chunky, sometimes appearing minutely granulose, dark greenish-gray to black; perithecia minute to small, 0.15–0.4 mm. across, scattered or more or less clustered, immersed to partly superficial, the wall dimidiate and centrally open below, the superficial portion subhemispherical or subconical, dull black, the ostiole minute, often scarcely visible; hypothecium and hymenium hyaline; paraphyses gelatinizing early, becoming indistinct and disappearing; asci clavate, inflated; spores 8, hyaline, oblong-ellipsoid, non-septate, $18\text{--}22 \times 8\text{--}9\ \mu$, irregularly arranged.

The algal host is *Pleurococcus*.

On a littoral quartz pebble, Orient, Long Island, New York, collected by Roy Latham (type) and from East Hampton, Long Island, collected by the same, April 20, 1926.

Thallus somewhat similar to *V. nigrescens* Pers. and *V. viridula* (Schr.) Ach., but distinguished by the granulose rather than areolate appearance of these two. Separated from the other maritime species found in the United States by the larger spores reaching $22\ \mu$ in length.

Thelidiella Fink, gen. nov.

A *Thelidium* Mass. thallo parasitico et inconspicuo, in hospitis thallo immerso differens.

4. *Thelidiella blastenicola* Fink, sp. nov.

Thallus parasiticus et inconspicuus, in hospitis thallo immersus; perithecia minutissima, 0.06–0.09 mm. lata, dimidiata et partim immersa, nigra, solitaria vel compluria in squamis aut apotheciis hospitis, supra hemisphaerica vel obscure subconoidea, ostiolo rarissime conspicuo; hypothecium et hymenium decolora; paraphyses gelatinose confluentes et mox evanescentes; asci late clavati, superne membrana incrassata cincti; sporae 8, decolores, ellipsoideo-dactyloideae, 1-septatae, demum ad septum leviter constrictae, loculo apicali majore, $9\text{--}11 \times 3\text{--}4\ \mu$, inconditae.

Thallus immersed in that of the lichen host and invisible; perithecia very minute, 0.06–0.09 mm. across, dimidiate and

partly immersed, black, seated 1—several on single squamules or apothecia of the host, the superficial portion hemispherical to obscurely subconical, the ostiole only very rarely and tardily visible; hypothecium and hymenium hyaline; paraphyses gelatinizing and disappearing early; asci broadly clavate, the wall not much thickened in the apical region; spores 8, hyaline, ellipsoid-dactyloid, 1-septate, the upper cell larger, becoming slightly constricted at the septum, $9-11 \times 3-4 \mu$, irregularly arranged.

The algal host is *Protococcus*.

On the thallus and apothecia of *Blastenia neomexicana* Fink, near Las Vegas, New Mexico, collected by Brother Anect, November 12, 1925 (type), Fink Herb. No. 15,528.

A genus similar to *Thelidium* Mass., but separated because of its habit of growth,—that is, it is found growing on another lichen. It may be questioned whether or not such plants are lichens but it is supposed that the hyphae come in contact with and derive some benefit from the algal cells within the lichen host. For this reason this new genus can be placed with the lichens.

5. ***Dermatocarpon moulinsii subpapillosum* Fink, var. nov.**

Subtus minute papillatus.

The lower surface minutely papillose, separating it from the species.

On sandstone ledge in Idaho, collected by Heller in 1896 (type), Fink Herb. No. 12,825, and from Waldron Island, Washington, July 10, 1906, Fink Coll. No. 276, Fink Herb. No. 5517.

6. ***Arthopyrenia dimidiata* Fink, sp. nov.**

Thallus tenuissimus vel tenuis, levis vel leviter confragosus, continuus vel rimosus et interdum areolatus, glaucus vel cinereus; perithecia minuta, 0.1–0.25 mm. lata, supra subhemisphaerica, obscure nigra, dimidiata; sporae demum 8, decolores, ellipsoideae, 1-vel rare 2-septatae, loculo apicali majore, $10-14 \times 5-6 \mu$, inconditae.

Thallus very thin to thin, smooth to somewhat rough, continuous to chinky and sometimes areolate, grayish to ashy; perithecia minute, 0.1–0.25 mm. across, the superficial portion subhemispherical, dull black, the wall dimidiate; hypothecium and hymenium hyaline; paraphyses interwoven and branched, remaining distinct (very plainly branched); asci broadly clavate, the wall little thickened in the apical region; spores reaching 8, hyaline, ellipsoid, 1- to rarely 2-septate, the upper cell larger, $10-14 \times 5-6 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On schistose granite near Ellsworth, Connecticut, collected by H. A. Green in 1895 (type), Fink Herb. No. 15,469.

Very similar to *A. distans* (Willey) Zahlbr., but that has spores $14-21 \times 5-7 \mu$. This specimen was labelled *Verrucaria distans* Willey, a species listed by Zahlbruckner under *Arthopyrenia distans* (Willey) Zahlbr. Cat. Lich. Univ. 1: 276, and also under *Thelidium distans* (Willey) Zahlbr. Cat. Lich. Univ. 1: 119. The distinct paraphyses of this specimen rule it out of *Thelidium*, and the smaller spores separate it from *A. distans*.

7. *Polyblastiopsis dealbens* Fink, sp. nov.

Thallus tenuis et glaucus, levis vel leviter confragosus, rimosus, interdum demum pulverulentus; perithecia minuta vel parva, 0.15-0.4 mm. lata, rotundata vel difformia, supra dejecta convexa, nigra aut albida pruinosa, ostiolo rare conspicuo; sporae 4-8, decolores, oblongo-ellipsoideae, 8-9-transverse septatae et 1-2-longitudinale septatae, $30-38 \times 15-16 \mu$, inconditae.

Thallus thin and ashy, smooth to slightly rough, chinky, sometimes becoming powdery; perithecia minute to small, 0.15-0.4 mm. across, round to irregular, the superficial portion depressed-convex; black or more commonly whitish pruinose, the ostiole rarely visible; hypothecium dark brown; paraphyses interwoven and branched; asci clavate; spores 4-8, hyaline, oblong-ellipsoid, 8-9-septate transversely and 1-2-septate longitudinally, $30-38 \times 15-16 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On trees in the Lookout Mountains, Tennessee, collected by W. W. Calkins (type), Fink Herb. No. 11,573, and in South Carolina collected by H. A. Green, Fink Herb. No. 11,252. The type specimen was labelled *Pyrenula dealbens* Nyl., but apparently no description was ever published by Nylander.

Similar to *P. lactea* (Mass.) Zahlbr., but differing in the somewhat powdery appearance of the thallus, the larger perithecia, and in the superficial portion of the perithecia. In *P. lactea* the superficial portion is strongly convex and not so commonly pruinose.

8. *Polyblastiopsis floridana* Fink, sp. nov.

Thallus tenuis vel mediocriter crassus, demum confragosus et verrucosus, flavo-cinereus vel fuscus; perithecia minuta vel parva, 0.15-0.4 mm. lata, immersa verrucis, dimidiata, apice nigro et conspicuo, ostiolo interdum conspicuo; sporae 4- rare 6 vel 8, decolores, ellipsoideae, 7-9-transverse septatae et 1-2-longitudinale septatae, $50-68 \times 13-16 \mu$, inconditae.

Thallus thin to moderately thick, becoming rough and warty, yellowish-ashy, varying toward brownish; perithecia minute to small, 0.15–0.4 mm. across, imbedded in thalloid warts, the wall dimidiate, the apex visible and black, with the ostiole sometimes showing; hypothecium hyaline or rarely tinged brownish; hymenium hyaline; paraphyses interwoven and branched; asci long clavate; spores 4– rarely 6 or 8, hyaline, ellipsoid, 7–9-septate transversely and 1–2-septate longitudinally, $50\text{--}68 \times 13\text{--}16 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On trees in Florida, collected by J. D. Smith (type), Fink Herb. No. 11,253. The specimen was labelled *Segestria floridana* Tuck. in herb., but apparently no description was ever written by Tuckerman.

Separated from the other species of this genus by the distinctly heavier thallus which becomes warty, and by the size of the spores.

9. *Porina cestrensis platyspora* Fink, var. nov.

Sporae $36\text{--}50 \times 5\text{--}9 \mu$, eis formae typicae speciei duplo latiores.

Spores $36\text{--}50 \times 5\text{--}9 \mu$, thus reaching twice the width usually found in the species.

On beech trees in a wood near Scipio, Indiana, collected by Bruce Fink, February 8, 1909 (type), Fink Herb. No. 8,889.

10. *Porina nucula heterospora* Fink, var. nov.

Sporae 5–13-septatae, majores quam eae formae typicae speciei, $65\text{--}92 \times 10\text{--}12 \mu$.

Spores larger than in the species, 5–13-septate, $65\text{--}92 \times 10\text{--}12 \mu$.

On trees in Florida, collected by W. W. Calkins (type), Fink Herb. No. 15,512.

11. *Porina olivacea microspora* Fink, var. nov.

Thallus tenuis, levis aut leviter rugosus vel rimosus, obscure olivaceofuscus; perithecia minuta, 0.15–0.25 mm. lata, hemisphaerica, dimidiata, nigra, ostiolo non conspicuo, leviter immerso; sporae 8, decolores, longo-ellipsoideae, 3-septatae, $15\text{--}22 \times 4\text{--}4.5 \mu$, inconditae.

Thallus superficial, thin, smooth or somewhat wrinkled or chinky, dark olive-brown; perithecia minute, 0.15–0.25 mm. across, hemispherical, the wall dimidiate, the ostiole invisible, slightly immersed, the superficial portion black; hypothecium and

hymenium hyaline; paraphyses hyaline, non septate, few and unbranched; asci clavate to cylindro-clavate; spores 8, hyaline, long-ellipsoid, 3-septate, $15-22 \times 4-4.5 \mu$, irregularly arranged.

On trees at Lonely Lake, New Hampshire, collected by W. G. Farlow (type), Fink Herb. No. 11,559, and from Chocorua, New Hampshire, Fink Herb. No. 11,558.

12. *Pyrenula Herrei* Fink, sp. nov.

Thallus tenuis, levis vel obscure scaber, cinereus vel virido-fuscus vel fuscus; perithecia minuta vel parva, 0.2-0.35 mm. lata, partim immersa vel adnata, nigra, nitida, dimidiata, hemisphaerica vel interdum subglobosa, ostiolo rare conspicuo; sporae 8, fuscae, fusiformae vel ellipsoideae, 3-septatae, loculis lentiformibus, $16-20 \times 6-8 \mu$.

Thallus rudimentary, the superficial portion thin, smooth or obscurely scurfy, ashy or greenish brown to brown; perithecia minute to small, 0.2-0.35 mm. across, partly immersed to adnate, black, often shiny, hemispherical or sometimes subglobose, the ostiole rarely visible, the wall dimidiata; hypothecium hyaline; hymenium brownish; paraphyses unbranched, distinct or semi-distinct; asci cylindrical or long-clavate; spores 8, brown, fusiform to ellipsoid, 3-septate, the cells lenticular, $16-20 \times 6-8 \mu$.

The algal host is *Trentepohlia*.

On trees in the Santa Cruz Peninsula, California, collected by A. W. Herre (type), Fink Herb. No. 13,044.

Somewhat similar to *P. nitida* (Weig.) Ach., but separated by the smaller perithecia with very inconspicuous ostiole and somewhat smaller spores of this specimen.

13. *Belonia americana* Fink, sp. nov.

Thallus tenuissimus vel tenuis, levis, cinereus vel albidus; perithecia parva vel mediocria, 0.3-0.8 mm. lata, partim immersa, velo tenui et albo formi thalli intacta, apice conspicua, nigra, nonnumquam ab margine alba cincta, ostiolo minuto plerumque inconspicuo et interdum ab velo albo tecto, excipulo integro, supra crasso, infra tenue; sporae 8, decolores, longe aciculares, demum 39-44-septatae, $170-250 \times 2-3 \mu$, parallelae.

Thallus very thin to thin, smooth, ashy-gray to whitish; perithecia small to middle-sized, 0.3-0.8 mm. across, partly immersed, covered by a thin, whitish thalloid veil, the apex visible, black, sometimes surrounded by a white border, the ostiole minute, usually invisible, and sometimes covered by a white layer, the wall complete, thick above and thin below; hypothecium tinged brownish; hymenium hyaline; paraphyses parallel, unbranched, coherent and indistinct; asci soon breaking down;

spores 8, hyaline, long acicular, reaching 39–44-septate, $170\text{--}250 \times 2\text{--}3 \mu$, parallelly arranged.

The algal host is *Protococcus*, instead of *Trentepohlia* as has been found for this genus.

On trees near Houston, Texas, collected by H. W. Ravenel (type), Fink Herb. No. 10,695.

The genus has not been reported previously from the United States. Zahlbruckner lists 4 species in his Cat. Lich. Univ. This is the first species recorded for the western hemisphere. It differs from *B. russula* Koerb., *B. fennica* Vainio, and *B. herculana* (Rehm) Hazsl. by the larger spores. No description of *B. terrigena* Eitner was seen.

14. *Arthonia diffusella* Fink, sp. nov.

Thallus tenuis, levis vel leviter confragosus, obscure albus vel cinereus; apothecia minuta vel parva, 0.1–0.3 mm. lata, rotundata vel difformia, solitaria aut rare frequentia, partim immersa vel adnata, disco plano vel leviter convexo, nigro; sporae 8, decolores, oblongo-ovoideae, 1–3-septatae, sed plerumque 2-septatae, uno aut duobus loculis apicalibus majoribus, $12\text{--}15 \times 3.5\text{--}4 \mu$, inconditae.

Thallus thin, smooth to slightly rough, dull white to ashy; apothecia minute to small, 0.1–0.3 mm. across, round to more frequently irregular, solitary or rarely clustered, partly immersed to adnate, the disk flat to slightly convex, black; hypothecium brownish; hymenium hyaline to tinged brownish; paraphyses interwoven and branched, often indistinct; asci subpyriform, the apical wall much thickened; spores 8, hyaline, oblong-ovoid, 1–3 but usually 2-septate, constricted at the septum with 1 or 2 upper cells commonly larger, $12\text{--}15 \times 3.5\text{--}4 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On old wood in a swamp near Koochenchink, Minnesota, collected by Bruce Fink July 30, 1901 (type), Fink Herb. No. 15,475. Also collected by A. H. Povah on Isle Royale, Michigan, summer of 1930, Povah Coll. No. 22.

Very similar to *A. diffusa* Nyl., but the apothecia are somewhat smaller and the spores are larger, at least in length.

15. *Arthonia rupicola* Fink, sp. nov.

Thallus tenuissimus, levis, late expansus, pallide glaucus vel cinereus, demum evanescentes; apothecia minuta, 0.1–0.25 mm. lata, adnata, rotundata vel difformia, disco convexo nigro; sporae 8, decolores, oblongae, uniseptatae, ad septum constrictae, loculo apicali majore, $10\text{--}15 \times 4.5\text{--}6 \mu$, inconditae.

Thallus very thin, smooth, widespread, pale greenish-gray to ashy, finally disappearing; apothecia minute, 0.1–0.25 mm. across, adnate, round to irregular, the disk convex, black; hypothecium tinged brownish; hymenium hyaline; paraphyses indistinct, appearing interwoven and branched; asci broadly clavate to subovoid, the apical wall considerably thickened; spores 8, hyaline, oblong, 1-septate, constricted at the septum, the upper cell larger, $10-15 \times 4.5-6 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On limestone rock near Oxford, Ohio, collected by Bruce Fink, May 11, 1927 (type).

Separated from the other species of *Arthonia* growing on rock and known from the United States by the very thin, smooth, light-colored thallus, and from *A. lapidicola* (Tayl.) Branth & Rostr. by the spores having unequal cells.

16. *Arthonia Willeyi* Tuck. sp. nov. in herb.

Thallus albidus opacus, mediocriter crassus, levis vel leviter confragosus; apothecia minuta vel parva, 0.1–0.35 mm. lata, roundata vel leviter difformia, partim immersa vel adnata, disco plano vel convexo, nigro; sporae 8, decolores, ovoideo-ellipsoideae, 1-septatae rare 2-septatae, $10-13 \times 3-4 \mu$.

Thallus dull white, of moderate thickness, smooth to slightly rough; apothecia minute to small, 0.1–0.35 mm. across, round to slightly irregular, partly immersed to adnate, the disk flat to convex, black; hypothecium and hymenium tinged pale yellowish; paraphyses indistinct; asci pyriform; spores 8, hyaline, ovoid-ellipsoid, 1-septate or rarely 2-septate, $10-13 \times 3-4 \mu$.

The algal host is *Trentepohlia*.

On trees near Athens, Illinois, collected by J. Wolf (type), Fink Herb. No. 12,443. This specimen bears a name by Tuckerman but apparently no description was written by him.

Similar to *A. diffusa* Nyl., but differing in the more persistent thallus and also in the spores which are only 1- or 2-septate.

Opegraphoidea Fink, gen. nov.

A *Opegrapha* Humb. thallo parasitico et inconspicuo, in hospitis thallo immerso differens.

17. *Opegraphoidea staurothelicola* Fink, sp. nov.

Thallus parasiticus et inconspicuus, in hospitis thallo immersus; apothecia brevia et angustissima, $1.5-2.5 \times 0.08-0.1$ mm., partim immersa demum emergentia, dispersa et recta vel frequentia et varia difformia, disco clauso et indicato linea dejecta, obscura et nigra, vel rare aperto et nigro, concavo vel

plano, excipulo nigro; hypothecium crassum et obscure fuscum; hymenium pallide luteo-fuscum; paraphyses decolores, graciles, ramosae et intricatae; asci late clavati, membrana ad apicem modice incrassata cincti; sporae demum 8, decolores vel demum fuscescentes, ellipsoideae vel uno extremo acuto, 3-septatae, loculis cylindricis, $13-15 \times 4.5-5 \mu$.

Thallus immersed in that of the lichen host and therefore invisible; apothecia short and very narrow, $1.5-2.5 \times 0.08-0.1 \text{ mm.}$, partly immersed to superficial, scattered and straight to clustered and variously irregular, the disk closed and indicated by an obscure, depressed black line, to rarely open, black, concave to flat, the exciple black; hypothecium thick and dark brown; hymenium pale yellowish-brown; paraphyses hyaline, slender, branched and interwoven; asci broadly clavate, the apical wall moderately thickened; spores reaching 8, hyaline to finally brownish, ellipsoid with one end often more pointed, 3-septate, the cells cylindrical, $13-15 \times 4.5-5 \mu$.

The algal host is *Trentepohlia*.

On *Staurothele umbrina* (Wahl.) Hellb. near Aberdeen, Brown County, Ohio, collected by W. A. Kellerman, November 14, 1900 (type).

A genus similar to *Opegrapha* Humb. but separated because the host is another lichen as in the case of *Thelidiella*, *Buelliella*, and others.

18. ***Graphis atrorubens* Tuck. sp. nov. in herb.**

Thallus mediocriter crassus, levis vel leviter confragosus et rimosus, viridescente glaucus; apothecia sat longa et angusta, $1-4 \times 0.2-0.4 \text{ mm.}$, partim immersa vel emergentia, plerumque curvula vel flexuosa rare ramosa, disco clauso vel aperto et rubicundo-nigro, excipulo rubicundo-fusco; sporae 8, decolores aut fuscescentes, oblongo-ellipsoideae, 5-7-septatae, $18-28 \times 5-7 \mu$.

Thallus moderately thick, smooth to somewhat rough and chunky, greenish-gray; apothecia moderately long and narrow, $1-4 \times 0.2-0.4 \text{ mm.}$, partly immersed to subsuperficial, usually curved to flexuous, seldom branched, the disk closed to open, reddish-black, the proper exciple and the hypothecium reddish-brown, the exciple covered laterally by a finally disappearing thalloid one; paraphyses strong, semidistinct; asci clavate; spores 8, hyaline or brownish when old, oblong-ellipsoid, 5-7-septate, $18-28 \times 5-7 \mu$.

The algal host is *Trentepohlia*.

On trees in Georgia, collected by Ravenel in 1881 (type), Fink Herb. No. 13,746, and in Florida, collected by Miss Wilson, Fink Herb. No. 10,936. The type specimen bears the name by Tucker-

man and is a portion of a specimen from his herbarium. Apparently it was not described by him.

Similar to *Graphis scripta* (L.) Ach. and its subspecies, but differing in the somewhat thicker thallus, and the apothecia which here are commonly shorter and rarely show any branching.

19. *Phaeographina explicans* Fink, sp. nov.

Thallus tenuis, levis, virido-flavus vel olivaceus; apothecia mediocriter longa et lata, $1-3 \times 0.2-0.4$ mm., partim immersa vel adnata, recta vel plerumque curva aut flexuosa, rare ramosa, interdum radiate aggregata, disco aperto et plano, nigrescente fusco vel obscure canente pruinoso, excipulo fusco; sporae 8, fuscae, oblongo-ellipsoideae, 3-7-transverse septatae et 1-longitudinale septatae, $21-35 \times 8-12 \mu$.

Thallus thin, smooth, greenish-yellow to olive-green; apothecia moderately long and wide, $1-3 \times 0.3-0.4$ mm. partly immersed to adnate, straight to much more commonly curved or flexuous, rarely branched, but more often clustered, sometimes radiately so, the disk open and flat, blackish brown or obscurely grayish-pruinose, the proper exciple dark brown; hypothecium brown; hymenium hyaline to brownish; paraphyses hyaline, coherent and indistinct; asci clavate; spores 8, brown, oblong-ellipsoid, 3-7-septate transversely and 1-septate longitudinally, $21-35 \times 8-12 \mu$.

The algal host is *Trentepohlia*.

On trees near Montgomery, Alabama, collected by Dr. R. P. Burke in 1916 (type), Fink Herb. No. 14,135, and near Boloxi, Mississippi, collected by S. M. Tracy in 1897, Tracy Coll. No. 4,033. The type specimen was labelled *Graphis dendritica explicans* Tuck. but apparently no description was written by Tuckerman.

Externally much like the species of *Opegrapha*. The apothecia are not so long as in our other species of *Phaeographina*. Somewhat similar to *P. columbiana* (Tuck.) Zahlbr. in the smaller spore sizes, but differing in the more deeply colored thallus.

20. *Chiodecton subochroleucum* Fink, sp. nov.

Thallus tenuis, flavido-albus, levis vel confragosus corruendo granulato; apothecia parva, 0.4-1 mm. lata, dispersa aut frequentia, adnata, rotundata vel difformia, disco plano, rare nigro, sed saepe albido-pruinoso, excipulo rare flexuoso mediocriter evoluto; sporae 8, decolores, 3-septatae, ellipsoideae vel ellipsoideo-acutae, $19-27 \times 5-6.5 \mu$.

Thallus thin, yellowish-white, smooth to rough and granulose crumbling; apothecia small, 0.4-1 mm. across, scattered or clus-

tered, adnate, round to irregular, the disk flat, rarely black, but much more commonly whitish pruinose, the exciple rarely flexuose, only moderately developed; hypothecium blackish-brown, extending under each apothecium into a stroma of the same color; hymenium hyaline; paraphyses sometimes branched; asci becoming broadly clavate; spores 8, hyaline, 3-septate, ellipsoid to ellipsoid-pointed, $19-27 \times 5-6.5 \mu$.

The algal host is *Trentepohlia*.

On trees in southern California, collected by Pringle (type), Fink Herb. No. 10,879, and by Hasse near San Diego, Fink Herb. No. 11,892.

Similar to *C. ochroleucum* Zahlbr., but with a less well-developed exciple, and spores only 3-septate but longer and not as wide.

21. *Ocellularia floridensis* Fink, sp. nov.

Thallus tenuis vel mediocriter crassus, levis vel confragosus, rimosus, cinereo-albus; apothecia parva, 0.5–0.8 mm. lata, immersa vel emergentia, disco alte concavo, nigro aut albido-pruinoso, excipulo proprio tenue, albido, inflexo, cincto alio thalli crassiore et difformo; sporae 8, decolores, oblongo-cylindricae, leviter flexuosae, 15–29-septatae, $118-180 \times 16-20 \mu$.

Thallus thin to moderately thick, smooth to rough, chinky, ashy-white; apothecia small, 0.5–0.8 mm. across, immersed to superficial, the disk deeply concave, black or whitish pruinose, the proper exciple thin, whitish, inflexed, surrounded by a thicker, irregular, thalloid one; hypothecium and hymenium hyaline; paraphyses unbranched, free or coherent; asci clavate or broadly clavate; spores 8, hyaline, oblong-cylindrical, slightly flexuous, 15–29-septate, $118-180 \times 16-20 \mu$.

The algal host is *Trentepohlia*.

On trees in Florida, specimen bears no collector's name or date of collection (type), Fink Herb. No. 13,094.

Similar to *O. domingensis* (Fée) Müll. Arg., but having 8 spores in each ascus. The herbarium specimen was labelled *Thelotrema lepadodes* Tuck.

22. *Pyrenopsis lecideella* Fink, sp. nov.

Thallus minute granulosus, formans crustam tenuem et inaequalem, canentem vel nigram, plus minusve continuam; apothecia minutissima vel minuta, 0.1–0.2 mm. lata, numerosa, partim immersa vel adnata, rotundata, disco leviter concavo demum plano et convexo, nigro et excipulo thalli tenue, integro

et nigro, mox evanescente; sporae 8, decolores, oblongo-ovoideae et planae in uno latere, $7-8 \times 4-4.5 \mu$, inconditae.

Thallus minutely granulose, forming a thin, uneven, grayish to black, more or less continuous crust; apothecia very minute to minute, 0.1–0.2 mm. across, numerous, partly immersed to adnate, round, the disk slightly concave to flat and convex, black, the thalloid exciple thin, entire, black, soon disappearing; hypothecium and hymenium hyaline; paraphyses hyaline, becoming coherent and semidistinct; asci clavate, with the apical wall moderately thickened; spores 8, hyaline, oblong-ovoid and flat on one side, $7-8 \times 4-4.5 \mu$, irregularly arranged.

The algal host is *Gloeocapsa*, in clusters surrounded by a pale brown sheath, much entwined and penetrated by the lichen hyphae.

On flat limestone pebble on high dry hill near Oxford, Ohio, collected by M. L. Lohman, May 21, 1927 (type).

The thallus is thinner than that of most of the species of *Pyrenopsis* from the United States. Similar to *P. fuscoatra* Fink in the thin irregular thallus, but separated by the open lecidea-like apothecia and the smaller spores.

23. *Psorotichia Hassei* Fink, sp. nov.

Thallus formatus crusta tenue, difformia, minute granulosa vel aliquantam coralloidea, olivaceo-fusca vel nigrante; apothecia minuta vel parva, 0.15–0.6 mm. lata, adnata, disco concavo vel leviter convexo, rubicundo-fusco et excipulo proprio tenue et saepe indistincto; sporae 8, decolores, non septatae, oblongae vel ovoideo-ellipsoideae, $16-24 \times 9-12 \mu$, inconditae.

Thallus composed of a thin, irregular, minutely granulose to somewhat coralloid, olive-brown to blackish crust; apothecia minute to small, 0.15–0.6 mm. across, adnate, numerous, the disk concave to slightly convex, reddish-brown, the proper exciple thin and often indistinct; hypothecium hyaline or tinged with yellowish-brown; hymenium hyaline; paraphyses unbranched, more or less coherent; asci cylindrico-clavate; spores 8, hyaline, non-septate, oblong to ovoid-ellipsoid, $16-24 \times 9-12 \mu$, irregularly arranged.

The algal host is an irregularly-shaped blue-green alga; apparently *Xanthocapsa*.

On soft disintegrating sandstone among moss, at 1650 meters in the San Jacinto Mountains, California, collected by H. E. Hasse (type), Fink Herb. No. 13,022.

The plant was reported by Hasse as *P. arnoldiana* Hepp. Zahlbruckner places this species under *Lemmopsis* Zahlbr. Our specimen is excluded from *Lemmopsis* as there is no plectenchymatous cortex. Similar to *P. Schaereri* (Mass.) Arn., but differing in the slightly thinner thallus, the smaller apothecia with a reddish brown instead of a black disk and the slightly smaller spores.

UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

DR. THAXTER'S METAL GUARD FOR MICROSCOPE SLIDES

WM. H. WESTON, JR.

(WITH TEXT FIGURES)

In consulting herbaria made up of specimens whose study requires microscopic examination of minute structural details, many have become convinced that it would be an ideal arrangement to have permanent mounts of such material available on the sheet with the herbarium specimen itself. If this were done, the often scanty material of irreplaceable type specimens would not be depleted by making temporary mounts for each examination, and the difficulty of consulting a card catalogue or lists to locate the slides stored in slide boxes far removed from the specimen would be avoided. Yet the problem of protecting such slides so that they will not be injured when kept with the packet of material on the herbarium sheet is a difficult one, for the material mounted on such slides in many instances does not lend itself to permanent mounting in balsam, Venetian turpentine, or gum damar, and hence must be mounted in pure glycerine¹ or lactophenol,^{2,3,4} sealed with King's cement,¹ balsam,⁵ or other sealing materials. This problem, however, was solved by Dr. Thaxter with his characteristic ingenuity by devising a metal guard which, when slipped over the permanent slide, protected it so successfully that even sealed mounts thus guarded could without injury be kept in a herbarium packet affixed to the same sheet as the specimen itself.

Realizing that this ingenious and useful slide guard would prove of great interest and value to other mycologists, the writer, with Dr. Thaxter's permission, described and demon-

¹ Bullard, C. Trans. Am. Microscopical Soc. Apr. 1921.

² Davis, W. H. Science. Dec. 10, 1929.

³ Linder, D. H. Science. Nov. 1, 1929.

⁴ Weston, W. H., Jr. Science. Nov. 8, 1929.

⁵ Diehl, W. W. Science. Mar. 8, 1929.

strated this device to the Mycological Section of the Botanical Society of America at the Cleveland meetings in 1930. Because many urged that some account of this device should be made available not only to mycologists but also to botanists in general, the writer tried to induce Dr. Thaxter to publish such a description, but he was too absorbed in work on the fifth volume on the Laboulbeniales to do so. As this slide guard is a typical example of the ingenious devices which Dr. Thaxter worked out from time to time in connection with his mycological investigations, and as it is a valuable and useful contrivance in itself, a brief description of it is presented here in the hope that it thus may have a two-fold interest to those in mycology and other branches of botany.

This slide protector consists essentially of a thin metal guard (FIG. 1) which slips over the slide (FIG. 2) protecting the cover-

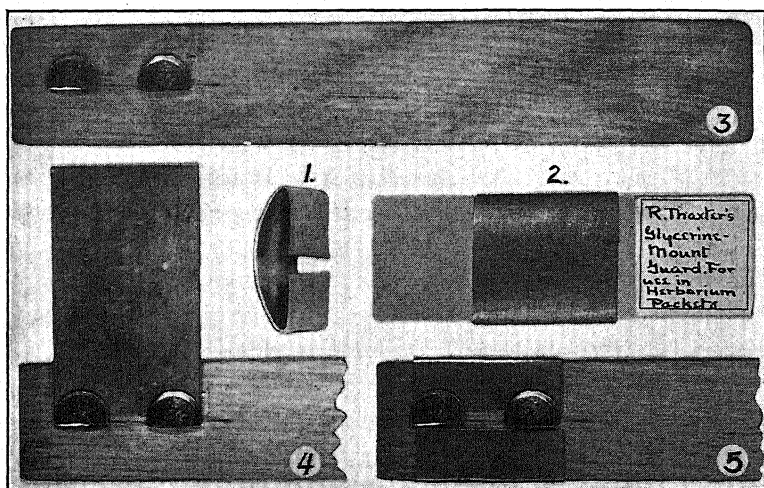


FIG. 1-5. Dr. Thaxter's metal guard for microscope slides.

glass of the mount itself with an arch of thin but springy metal and gripping the edge and lower surface of the slide securely with its two flange-like ends. For constructing these guards, sheet zinc or brass about ten one-thousandths of an inch thick is used, either metal meeting the requirements of being thin, light, easily worked, and sufficiently springy to enable the completed guard to grip the slide and to protect the coverglass of the mount

from any ordinary pressure or impact. The metal sheeting is first cut into strips 2" long and of a width from $1\frac{1}{8}$ " to 2", depending on whether a slide with one, two, or more mounts is to be protected. These metal strips are then easily and rapidly bent by hand into the proper shape over a hard wood form. In Dr. Thaxter's original model, which is illustrated here (FIG. 3), the form is of smooth, hard wood about 6" long, $15/16$ " wide, flat on the lower side, and slightly convex on the opposite face as it gradually arches to a thickness of about $3/16$ ". One end of this form, for a length of a little over 2", is very accurately shaped and slightly tapered so that the metal when bent can easily be slipped off. Two strong thumb tacks, with half of their flat metal heads cut off, are set, slightly projecting, just to one side of the middle of the flat under surface, their cut edges lying along the median line. The remaining 4" serves as a handle by which the form is held when the metal strip is being bent.

In making the guards, one end of the metal strip is fitted under the heads of the thumb tacks as in figure 4, and the strip is then bent around the form until the other end meets the thumb tacks as in figure 5.

With such a form the metal strips may easily and rapidly be shaped, and in a few minutes a supply may be produced to be kept on hand ready for use. As there is some variation in the thickness, and even in the width, of standard size microscope slides, and considerable variation in the height and area of the sealed coverglasses of finished mounts, a slight re-forming of the metal clip is necessary in adjusting the guard to the individual slide to be protected. With little difficulty, however, the metal guard may be re-formed with the fingers until it holds the slide firmly gripped with its flanges and adequately protects the mount with its arched center.

To meet individual needs, protectors of various widths may be made on the same form, and metal strips of greater or less thickness or springiness may be used. The original form used by Dr. Thaxter was made of wood and this has proved wholly satisfactory, but it would, of course, be possible to make a similar form of easily worked metal with some centering and holding device other than the thumb tacks to facilitate gripping and bending the

metal strips in the proper position. It would be easy also to devise stamping machinery which would rapidly turn out such guards in quantity, but such machinery would be expensive, and as the guards can be easily and quickly made by hand it is doubtful if the demand would justify any laboratory supply company in going to this expense.

This metal guard, as originally devised by Dr. Thaxter and made by hand on a simple wooden form, has proved entirely satisfactory and large numbers of slides protected by these metal clamps have been inserted in paper packets affixed to sheets of fungus specimens in the Farlow Herbarium where, after over two years of the treatment to which such sheets are subjected, the slides are still in perfect condition.

LABORATORIES OF CRYPTOGRAMIC BOTANY,
HARVARD UNIVERSITY

SOME NEW SPECIES OF HYPOXYLON

J. H. MILLER

(WITH PLATES 39 AND 40 AND 1 TEXT FIGURE)

The descriptions of the following new species of *Hypoxylon* are based on specimens sent the writer by Dr. Roland Thaxter and Prof. A. S. Muller, and others of his own collecting.

The forms which are given varietal names do not differ from the established species in sufficient characters to warrant specific rank. In most cases they are distinct only in ascospore dimensions. This latter character varies considerably with material of different ages, but there is a fairly definite maximum limit. For example, *Hypoxylon serpens* Pers. ex Fries has ascospores which vary in length from 10 to 15 μ . This species was described from Europe and all material examined there falls within these limits. In America, however, the European form is very common, but occasionally one finds what is apparently the same thing except for the much larger ascospores; that is, between 15 and 20 μ , in length. These variants may be mutants or hybrids, but in view of the present lack of knowledge of inheritance in the fungi, it seems best to give them varietal rank.

1. *Hypoxylon aeruginosum* sp. nov.

Type: No. 884 Harvard Cryptogamic Herbarium. Cotype no. 5950 Herbarium J. H. Miller.

PLATE 39, FIGS. 1-2, TEXT FIG. 1, A

Stroma late effusum, suborbiculare, 1-2 cm. longum, $\frac{1}{2}$ -1 cm. latum, $\frac{1}{2}$ -2 mm. crassum, applanatum vel irregulariter pulvinatum; ectostroma villo furfuraceo, aeruginoso; entostroma lignosum, atro-fuscum vel nigrum; peritheciis subprominulis, parvis, globosis, vel mutua pressione deformatis, verticibus vix emergentibus, ostiolis umbilicatis, 300-500 μ in diam.; ascis cylindricis (pars spor.) 40-50 μ , pedicello 40-60 μ longo; ascosporis oblique monostichis, plano-convexis, brunneis, 7.2-10 \times 3.5-4.5 μ .

This fungus occurs on bark and decorticated wood, becoming more pulvinate and thicker on the former. No conidia have been found.

Collected by Dr. D. H. Linder, Feb. 2, 1924, Pl. Voyheid, British, Guiana.

This species is readily distinguished by its peculiar copper-blue color, which must be exceedingly rare in the genus. With

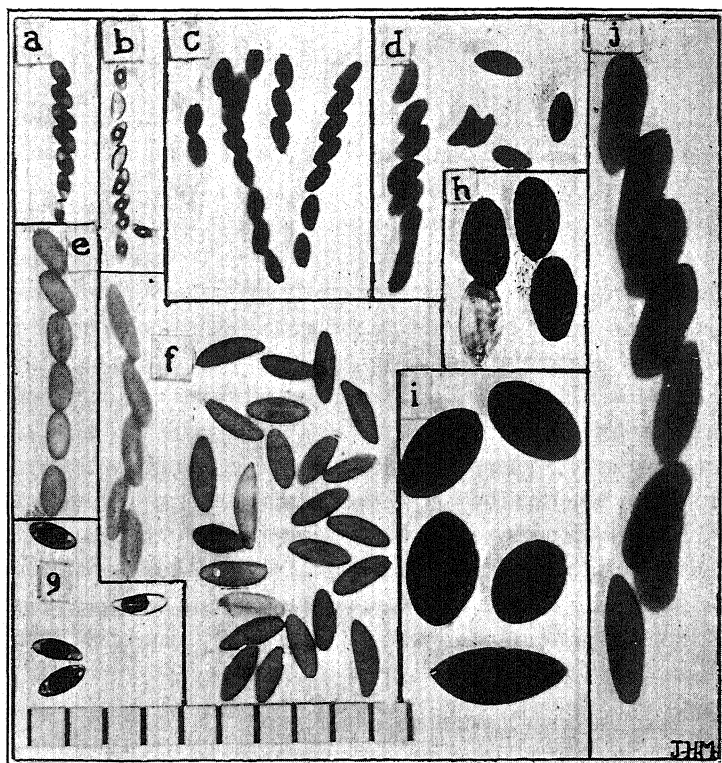


FIG. 1. Photomicrographs of ascospores of species and varieties of *Hypoxylon* listed below. All were photographed with the same camera and microscope combinations: a, *Hypoxylon aeruginosum*; b, *H. erythrostroma*; c, *H. croceum*; d, *H. Mulleri*; e, *H. cinereo-lilacinum*; f, *H. serpens* var. *macrospora*; g, *H. serpens*; h, *H. regale*; i, *H. regale* var. *macrospora*; j, *H. vogesiacum* var. *macrospora*.

its colored ectostroma, non-carbonous entostroma, non-extruded ostiola, it falls in the group with *H. rubiginosum* Pers. ex Fries, *H. haematostroma* Mont., *H. papillatum* Ellis & Ev., and others. The young stroma of *H. papillatum* more nearly approaches it in color, but it is more of a green than a blue. The colored ecto-

stroma wears off in old specimens leaving a black stroma which would be difficult to identify.

The name *aeruginosum* was suggested by Dr. Thaxter.

2. *Hypoxylon croceum* sp. nov.

Type: No. 6610 Herbarium J. H. Miller. Cotype deposited at Harvard Herbarium and at the Kew Herbarium.

PLATE 39, FIGS. 3-4, TEXT FIG. 1, C

Stroma elongatum effusum vel pulvinatum, discretum, 1-6 mm. diam. vel undulato-confluens, 1-2 mm. crassum, primo applanatum, maturitate efformatum ex peritheciis liberis verticibus, tuberculosum, laete crocium maturitate fulvo-brunneum; entostroma coriaceum vel lignosum; peritheciis parvis, subconfertis, ovato-globosis, vertice prominentibus, ostiolo papillato, nigri punctiformi, deinde pertuso, ascis longis attenuatis (pars spor.) 45-55 μ , pedicellis usque 40-50 μ longis; ascosporis plano-convexis, 1-2 guttis, brunneis deinde opacis, 8-11 \times 4-5 μ . Conidia minuta, hyalina, ovata, vel oblonga, 4-5 μ diam., initio ectostroma vestientia.

On *Liriodendron tulipifera* L. covering the lower side of an old log. Mountain City, Ga., Aug. 7, 1928. Also found at Highlands, N. C., Aug. 1932.

The fresh, initial stage, of this species is bright yellow resembling the plasmodial stage of a Myxomycete, but when dried it assumes a dull yellow-brown color. There are two other species in shades of yellow, and both have effused stromata with very prominent perithecia. One however, *H. Morgani* Ellis & Ev., is readily distinguishable by having ascospores 35-38 μ in length, and the other, *H. chrysoconium* Berk. & Br., has more of an orange colored ectostroma than yellow, with perithecia more widely separated in the stroma.

3. *Hypoxylon erythrostroma* sp. nov.

Type: No. 2 Herbarium of R. Thaxter, Florida Collection.

PLATE 39, FIGS. 5-6, TEXT FIG. 1, B

Stroma late effusum, leve et applanatum, in ligno decorticato, vel undulatum, crasso margine rotundato, in ligno corticato, 1-2 mm. altum; ectostroma laete griseo-brunneum dein cinereo-nigrescens cum margine cinereo; intus inter perithecia sanguineum; entostroma carneo-coriaceum vel lignosum; peritheciis monostichis in margine stromatis, $\frac{1}{2}$ -1 mm. diam., globoso-angularis vertice rotundato haud emergente, ostiola umbilicata, minutissime pertusa; ascis cylindricis, stipitatis (pars. spor.), 40-50 μ longo; ascosporis brunneis, oblongo-ellipticis, in aetate plano-convexis, 6.5-9 \times 3-4.5 μ .

Collected by R. Thaxter, no. 2 and no. 7, Daytona, Fla. and no. 16 Cocoanut Grove, Fla. Host deciduous tree.

This species approaches *H. rutilum* Tul. and *H. jecorinum* Berk & Br. The ascospore measurements as well as the blood-red particles between the perithecia are common to the three. It differs from the former in lacking the definitely exerted perithecial vertices and from the latter in the color of the ectostroma. The color in *H. jecorinum* varies from bright red to yellowish-red, while in *H. erythrostroma* the color is brownish-gray to a very pale gray.

4. *Hypoxyylon Mulleri* sp. nov.

Type: No. 6618, Herbarium J. H. Miller. Cotype deposited in Harvard Cryptogamic Herbarium and at Kew Herbarium.

PLATE 39, FIGS. 7-8, TEXT FIG. 1, D

Stroma convexo-pulvinatum, 1-8 cm. longum, 1-3 cm. latum, .5-1 cm. crassum; ectostroma primo pulverulento-brunneum, in aetate nigrum, carbonaceum; entostroma lignosum, subpulveraceum, fibrosum, spurie zonatum; peritheciis periphericis, angulatis, elongatis, stipatis, vertice subapplanato haud emergente, ostiolis umbilicatis, opacis, minutis; ascosporis brunneis aetate opacis, ellipticis, rotundatis vel plano-convexis, $11.2-15 \times 5.6-6.6 \mu$. In ligno.

Collected A. S. Muller, Las Vegas, P. R., June 19, 1929.

This species resembles *H. placentiforme* in form, but differs in the brown rather than purplish-red color of the latter and in the rough surface due to partially projecting perithecia. Large forms of *H. truncatum* (Schw. ex Fries) Mill. closely approach this one, but are distinct in the possession of papillate ostiola and smaller ascospores.

There are two or three faintly distinct zones in the entostroma, which would make this a transitional form between *Hypoxyylon* and *Daldinia*. Lloyd (2: 1181) creates the genus *Hypodiscus* for such forms, but there are too many genera now in the Xylariaceae separated only on stromal form. This character varies so constantly with conditions of growth, that when taken alone, is not sufficient for generic separations. The genus *Hypodiscus* should therefore be discarded.

5. *Hypoxyylon cinereo-lilacinum* sp. nov.

Type: No. 1180, Ellis & Ev. N. Am. Fungi, Cornell Department of Plant Pathology Herbarium, sub *H. atropurpureum*.

PLATE 40, FIGS. 1-2, TEXT FIG. 1, E

Stroma late effusum, indeterminatum, tenuissimum, $3-4 \times 1-2$ cm., .5-1 mm. crassum, leve vel cum ligno corticato undulatum, coriaceum, haud carbonaceum; ectostroma primo laete griseum, paene album, in aetate cinereo-lilacinum, margine albo, atris ostioliis distinctum et in senectute paene nigrum; entostroma nigrum; peritheciis globosis vel oblongis, monostichiis valde stipatis, compressis, ex ectostromate emergentibus ostioliis brevibus, papillatis, truncatis; ascis cylindricis, $55-75 \mu$ (pars spor.) et $40-50 \mu$ pedicello; ascosporis plano-convexis vel cylindricis, brunneis, $11-15 \times 5-6.5 \mu$, saepissime $12 \times 5 \mu$. In ligno.

The light purple-gray color, very thin plane stroma with white sterile margin, and no perithecial elevations, distinguish this species.

It occurs chiefly in the middle western United States, but Ellis cites it from Canada and from New York. Most of the specimens seen by the writer are from Iowa, Kansas and Tennessee.

Ellis determined this as *H. atropurpureum* Fries, but he was mistaken as that name was applied by Fries to the effused form of *H. multifforme* Fries.

The nearest related species is *H. fuscillum* (Rehm) Mill., based on exsicc. no. 481, W. H. Long from Texas. The writer finds the ascospores in that specimen to be $12-17 \times 6-8.5 \mu$, consistently larger than in the above species. Also Rehm's species is distinguished by its carbonous stroma. The color of the ectostroma is very similar in both species.

Superficially this species resembles *H. albotictum* (Morg.) Mill., but differs in possessing black papillate ostiola instead of the light colored umbilicate ones of the latter.

Specimens examined: Fungi Columb. no. 241, sub *H. atropurpureum* Fries, Cornell University; Holway no. 176, Iowa University Herbarium no. 6, 1896; Ellis & Ev. N. Am. Fungi, no. 1180, collected Holway, Decorah, Ia.; R. P. White nos. 1 and 5, Manhattan, Kans., Dec. and Feb. 1922; Thaxter nos. 71-76, Burbank, Tenn.

6. *HYPOXYLON VOGESII* Pers. ex Sacc. var. **macrosporum** var. nov.

Type: No. 7067, Herbarium J. H. Miller. Cotype in University of Michigan Herbarium.

PLATE 40, FIGS. 7-8, TEXT FIG. 1, J

Differt ab *H. vogesiaco* majoribus ascosporis.

The ascospores in this variety differ from those of the species in possession of larger dimensions, $26.2-37.8 \times 7-12 \mu$. Aside from the larger ascospores the other characters are similar to those of the species.

Collected by C. H. Kauffman and C. L. Wehmeyer in Wyoming.

Note on the species *Hypoxylon vogesiacum*: This form has not been well understood in the United States nor in Europe. The type no. 765 Moug. et Nestl. Stirp. Vog.-rhen., at the University of Leiden, is an old specimen, and has ascospores measuring $14-20 \times 6-8 \mu$. Smaller spores than the maximum are to be found in collections of younger stromata. The stroma is widely effused and fairly smooth, without marked perithecial elevations. This character, however, varies in European specimens to ones with protruding perithecia as in exsicc. no. 238 Myc. Carp. by Petrak (sub *H. aeneum* Nits.). The color ranges from a reddish-purple to brownish-purple to almost black in age. Nitschke (4. 35) describes the spores of *H. fuscum* Pers. ex Fries as $12-20 \mu$, in length, which would include the species *vogesiacum*, however these two species are distinct in spore measurements and in color.

The red series of *Hypoxylon* presents a difficult problem. In Europe there are *rubiginosum*, with ascospores $9-11 \times 4-6 \mu$, and *vogesiacum* with ones $14-20 \times 6-8 \mu$, with no transitional forms. *H. fuscum* does not lie in this series because it does not usually present the shades of red found here. The tropical forms begin with one with smaller ascospores than those of *rubiginosum* and terminate with ones up to 37.8μ , in length. Many specific names have been applied to members of this group, but Theissen (6: 151) concludes that the series constitutes a single species. This would appear logical except that in other parts of the world there are ones that are constant in the spore dimensions and with no intervening forms to bridge the gaps, as one finds in the tropics. Therefore, if we split this natural group into species we must think of them only as local entities.

The tropical form nearest *vogesiacum*, according to European specimens, would be *H. haematostroma* Mont. Spores of the

cotype at Kew are $14-18 \times 7-9 \mu$. Cooke (1: 124) describes them as $10-12 \times 3.5 \mu$, and the Montagne specimen at Kew is the one he had access to. He must have measured spores of a specimen of *rubiginosum*, which is on the same sheet. This error was probably copied by Theissen (l. c. 149) as he uses $10-13 \times 4.5-5.5 \mu$. The latter (l. c. 145) also used the names *H. vividum* Berk & Br. and *H. haematites* Lév. ex Cooke as distinct species as does Rick (5: 27) more recently. Types of the latter two are in Kew and are identical with *haematostroma* and the latter name has priority.

Under *H. haematites* Theissen (l. c. 146) describes a variety *microspora* (sp. $15.5-21 \times 7.5-11 \mu$) and a variety *macrospora* (sp. $20-27 \times 12-14 \mu$). The writer has specimens from Brazil named by Theissen *haematites* which are very similar to the European or Canadian specimens of *vogesiacum*. A dark purplish-red color is seen in both Brazilian and European specimens and the ascospores are equal. The shade of red or purple, however, in this group has practically no diagnostic value as this depends entirely on the amount of moisture present during the development of the stroma and on the amount of light and on the age.

H. vogesiacum then is world wide in distribution and belongs in the red series with ascospores $14-20 \times 6-8 \mu$, a little larger than those of *H. haematostroma*, and is found chiefly in the cold temperate regions, while the other species is chiefly confined to the tropics. Also usually in *haematostroma* there are blood-red particles between the perithecia, and this is not so evident in *vogesiacum*.

The variety described here is one of *vogesiacum* rather than of *haematites* as the latter name is a nomen nudum.

7. *HYPOXYLON SERPENS* Pers. ex Fries var. *macrosporum* var. nov.

Type: No. 7090, Herbarium J. H. Miller.

PLATE 40, FIGS. 3-4, TEXT FIG. 1, F

Differt ab *H. serpenti* majoribus ascosporis.

The ascospores in the variety are $13-22 \times 5-8 \mu$. The other characters are the same as those of the species.

The Persoon type of *serpens* has ascospores (TEXT FIG. 1, G) $11-15 \times 5-7 \mu$. The writer has found no European specimens

with the appearance of *serpens*, but with the large spores of this variety. This form of the species is common in the western United States, and has been found from Canada to Georgia in the east. Like the species it appears to have no special host plant, but occurs on dead wood of many deciduous trees. The type is from Idaho, Aug. 1922.

It differs from *H. semiimmersum* Nits. in possessing narrowly navicular ascospores instead of the broadly fusoid ones of that species. Also the stroma is usually widely effused as is typical of *serpens*, and is not composed of just a few perithecia as is *semiimmersum*.

8. *HYPOXYLON REGALE* Morg. var. **macrosporum** var. nov.

Type: No. 6867 Herbarium J. H. Miller.

PLATE 40, FIGS. 5-6, TEXT FIG. 1, I

Differt ab *H. regali* majoribus ascosporis.

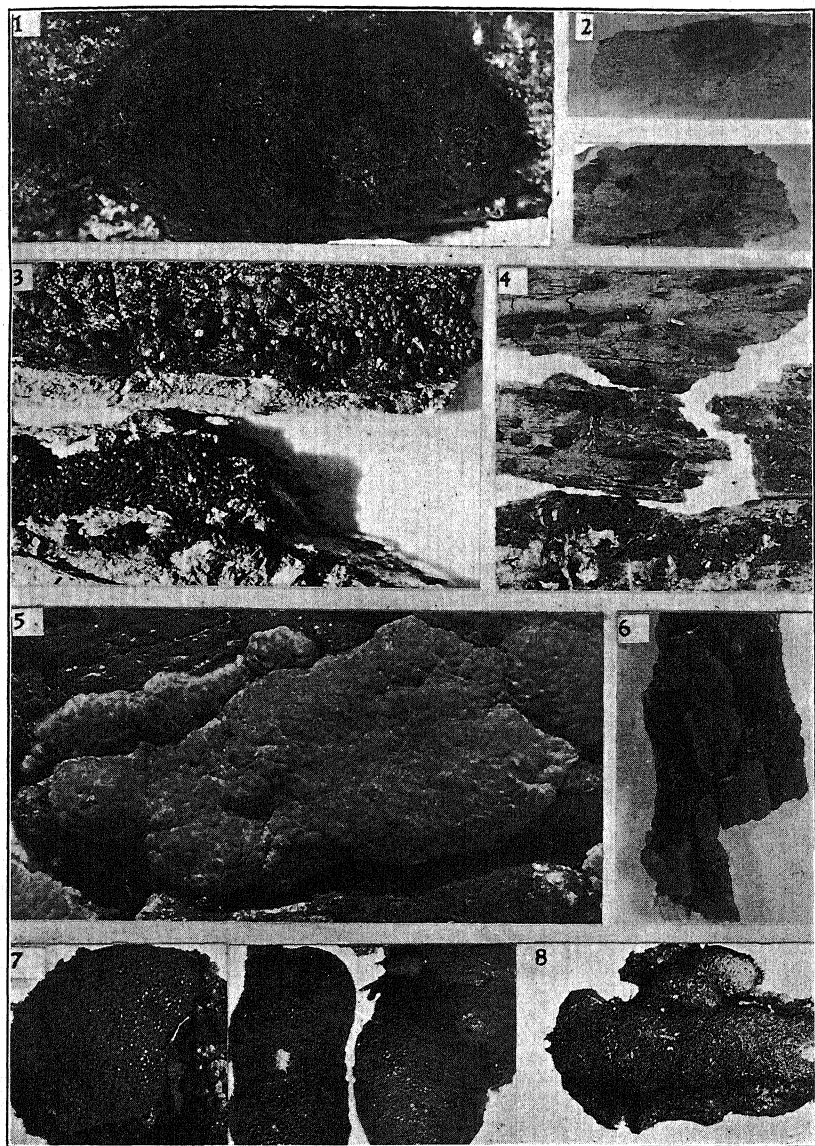
This variety differs in possession of larger ascospores, $25-40 \times 14-20 \mu$.

Collected on dead log of *Quercus montana*, Whitehall, Ga. Nov. 7, 1930.

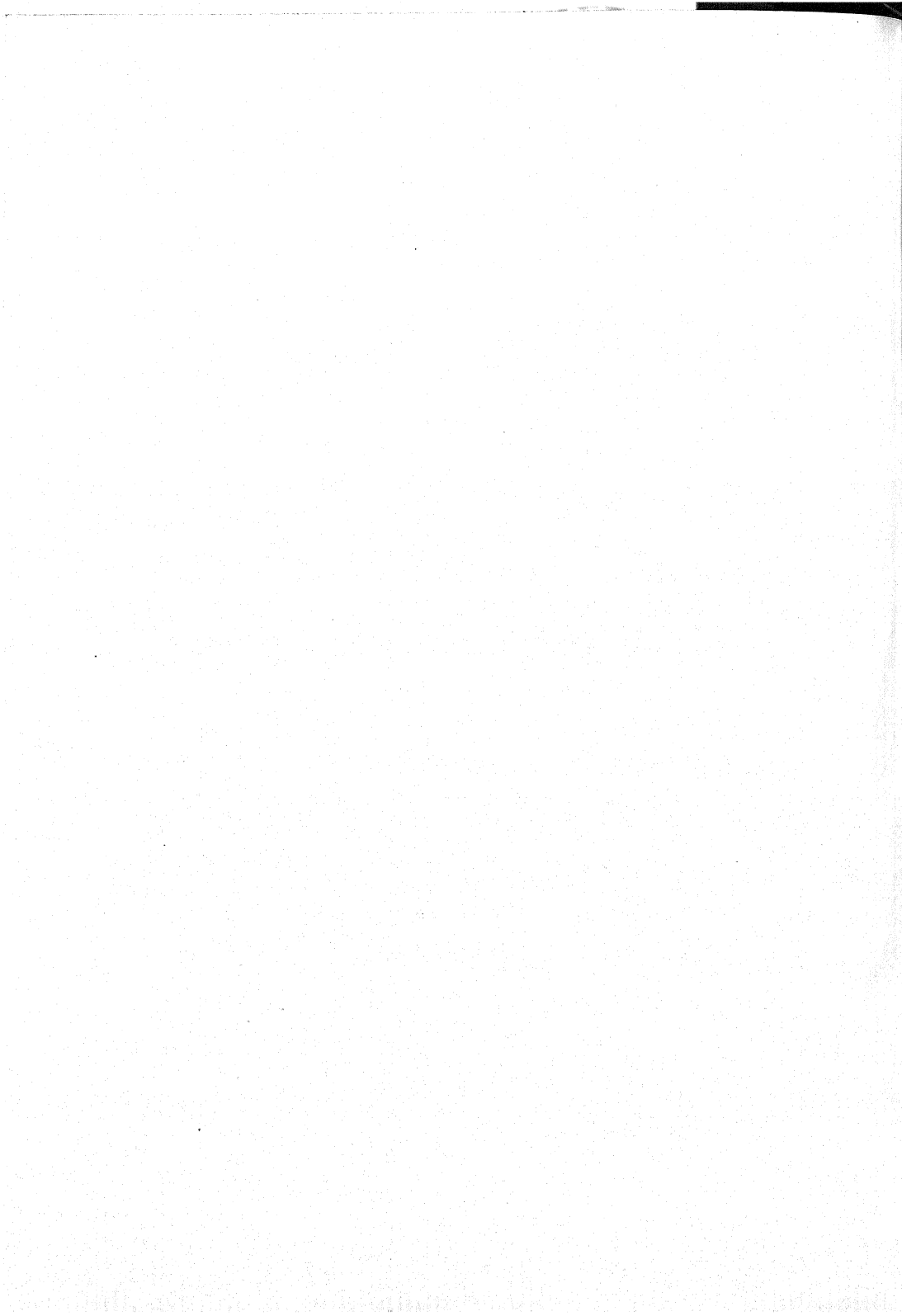
The stroma, as with the species, is very small, consisting of a few perithecia connected by a covering of black ectostroma. The perithecia are seated directly in the wood, and there is very little entostroma. It is found chiefly on decorticated oak wood, and has the same general appearance as the European species *H. semiimmersum* and *H. udum* Pers. ex Berk.

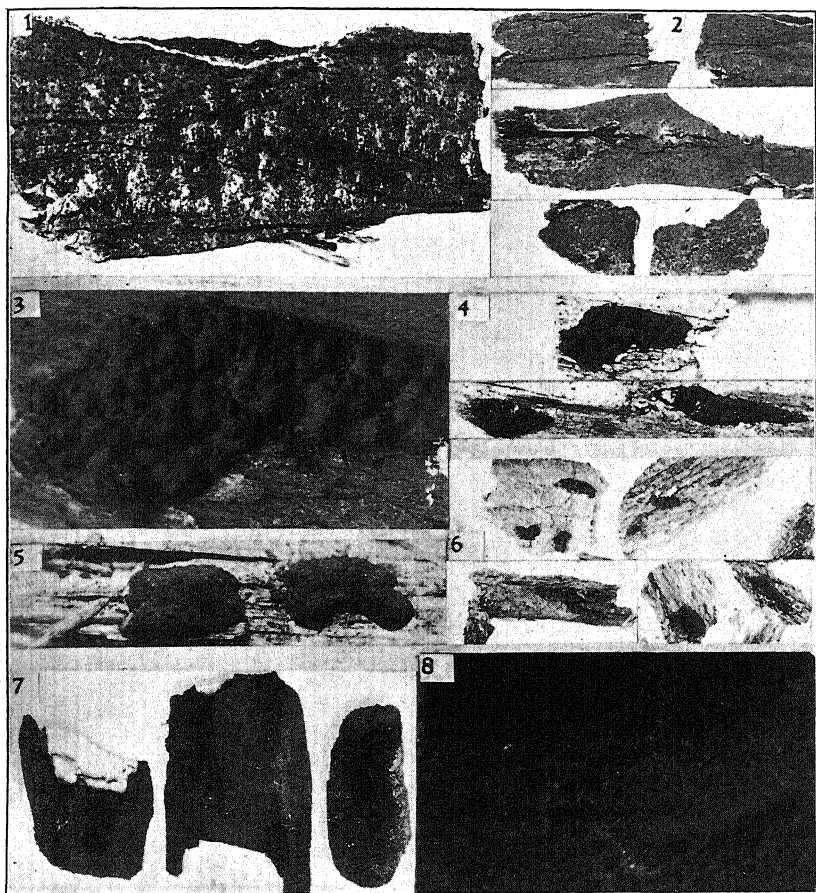
The Morgan type of the species has ascospores $20-27 \times 10-14 \mu$ (TEXT FIG. 1, H), usually $25 \times 12 \mu$, with a tendency to become fusoid as are those of *semiimmersum*. The latter species and *udum* apparently occur only in Europe, while *H. regale* and the variety occur in the United States. In spore characters *H. regale* is a connecting link between the two European species, and the variety of *regale* possesses ascospores much larger than *udum*.

UNIVERSITY OF GEORGIA,
ATHENS, GEORGIA



HYPOXYLON





HYPXYLON



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EXPLANATION OF PLATES

PLATE 39

Fig. 1. *Hypoxylon aeruginosum* $\times 15$, type, collected by D. F. Linder, British Guiana; 2. The above natural size; 3. *Hypoxylon croceum* $\times 5$, type, from Mountain City, Ga.; 4. The above nat. size, showing young undifferentiated stromata in upper part of cut and mature perithecia below; 5. *Hypoxylon erythrostroma* $\times 15$, type, from Daytona, Fla.; 6. The above nat. size; 7. *Hypoxylon Mulleri* $\times 4$, type, from Porto Rico; 8. The above nat. size.

PLATE 40

Fig. 1. *Hypoxylon cinereo-lilacinum* $\times 8$, type, Ellis & Ev. *N. Am. Fungi*, no. 1180; 2. The above nat. size; 3. *Hypoxylon serpens* var. *macrosporum* $\times 10$, type from Idaho, collected by L. E. Wehmeyer, Aug. 21, 1922; 4. The above nat. size; 5. *Hypoxylon regale* var. *macrosporum* $\times 20$, type, from Whitehall, Ga.; 6. The above nat. size; 7. *Hypoxylon vogesiacum* var. *macrosporum* $\times 2$, type, from Wyoming, collected by C. H. Kauffman and L. E. Wehmeyer; 8. The above $\times 10$.

NOTES AND BRIEF ARTICLES

THE MYCOLOGICAL FORAY

(WITH 1 TEXT FIGURE)

The first summer meeting of the Mycological Society of America, in the form of a foray, will be held at Highlands, North Carolina, August 17 to 19, 1933. The Board of Trustees, the Director, and Members of the Highlands Museum and Biological Laboratory, located at Highlands, extend a cordial invitation to



FIG. 1. Ravanel Lake, with Mt. Satulah in background. The Highlands Laboratory is situated on the banks of the Lake.

all mycologists to avail themselves of the favorable opportunity to collect in the Southern Appalachian Mountains.

Highlands is located in Macon County, southwestern North Carolina, near the Georgia and South Carolina boundary lines. It is accessible by good roads through Asheville, Knoxville or Atlanta. Satisfactory hotel accommodations at reasonable rates may be had in the village. Since Highlands is situated on a

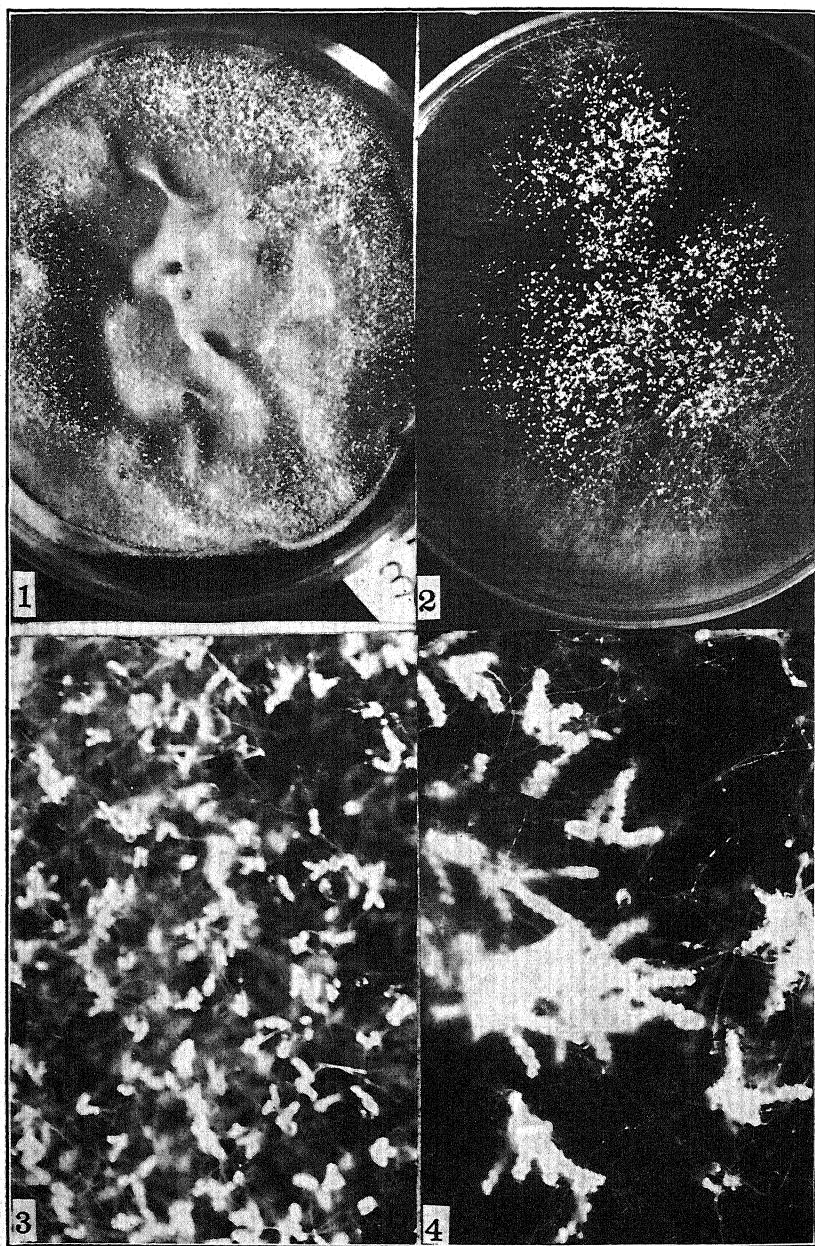
plateau at an elevation of about 4000 feet, pleasant days and cool nights may be guaranteed.

As is well known, rainfall is heavy in the Southern Appalachian Mountains. At Highlands, the average annual precipitation is about 90 inches. Moreover, the vegetation there is heavy and varied. Within the confines of the plateau, one finds dense forests (some virgin), open woods, gorges, grassy flats, and a few artificial lakes, all within short distances of the laboratory.

The laboratory itself is new and well-built. It is equipped with running water and electricity. A moderate supply of blotter-driers and plant press equipment, an electrically heated drier, and 3 or 4 microscopes are available. Other items, such as a vasculum, incidental to field collecting should be brought by those attending the foray.

Visiting mycologists will be given opportunity to visit the Great Smoky Mountains National Park. The Park may be reached by good road within two hours from Highlands. In normal seasons, fungi are likewise abundant in the Great Smokies. Those who may care to remain over night near the Park area will find excellent accommodations at the Mountain View Hotel, Gatlinburg, Tennessee.

W. C. COKER, E. E. REINKE, AND L. R. HESLER,
Committee on Arrangements.



DISPIRA CORNUTA

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXV SEPTEMBER-OCTOBER, 1933

No. 5

GROWTH OF DISPIRA CORNUTA IN ARTIFICIAL CULTURE¹

THEODORE T. AYERS²

(WITH PLATE 41)

Dispira cornuta van Tiegh. has been regarded hitherto as an obligate parasite on members of the Mucorales. This is due, probably to the fact that van Tieghem (10) in the initial study of this fungus found that the spores in hanging drops of nutrient media enlarged, produced short germ tubes and then remained quiescent.

The writer was unsuccessful in his initial attempts to culture the organism without a host on such common laboratory media as potato, oatmeal, bean pod, nutrient agars because, as he learned later, these media are unsuitable for its growth. Failing to culture the fungus on these media, an attempt was made to cultivate it on substances of high protein content to which no agar had been added. Previously Sawyer (8) demonstrated that this type of media was suitable for cultivation of certain parasites on animals as species of *Entomophthora* and *Empusa*. And on this type of media, *D. cornuta* was cultivated successfully without a host for the first time. The results of this investigation are presented in the following paper since they may interest others studying fungi in culture.

¹ Contribution from the Laboratories of Cryptogamic Botany, Harvard University, No. 107.

² The writer wishes to express his appreciation to Dr. W. H. Weston, Jr., at whose suggestion this research was undertaken, for stimulating encouragement and helpful criticism during the progress of this investigation and the preparation of the manuscript.

HISTORY OF THE FUNGUS

Dispira cornuta was reported originally from France in 1875 by van Tieghem (10). Later (1895) a fungus similar to *D. cornuta* was described from North America as *D. americana* by Thaxter (9). However, in 1906, Bainier (1) emended van Tieghem's description and illustrations and showed that *D. cornuta* and *D. americana* were identical. More recently (1926) Elliott (5) described from Great Britain *D. circinata* which differed from *D. cornuta* chiefly in that the upright, fertile hyphae branched three to six times (later states five to six) instead of twice as is typical of *D. cornuta*. From various sources, the writer has collected six times a fungus which agrees with Bainier's (1) description and illustrations of *D. cornuta*. Cultures isolated from these collections exhibited considerable proliferation of the heads, the sterile horn-like projections at the base of the fertile heads, and the sterigmata. Also the fertile hyphae branched dichotomously as well as pseudodichotomously. They produced not only two branches (PLATE 41, FIGS. 2, 3) as described for *D. cornuta* but also three to five branches as illustrated for *D. circinata*. Therefore, with these variations in mind, it seems justifiable to assume that *D. cornuta*, *D. americana* and *D. circinata* are synonyms for the same fungus and the name *D. cornuta* van Tiegh. should be used because of its priority.

MATERIALS AND METHODS

Collections of *D. cornuta* on its natural hosts were secured easily from hog and rat dung placed on moist sphagnum in damp chambers. In these cultures, the first of the coprophilous *Mucorales* to appear were species of *Pilobolus*, then species of *Mucor* on which, after about ten days, *Dispira cornuta* developed. Fragments of *Mucor* (PLATE 41, FIG. 3) with its parasite were transferred to tubes of agar media and allowed to stand until the sporangiophores of *Dispira* had raised themselves well above the host. Parts of the sporangiophores together with spores (PLATE 41, FIG. 4) were then removed with a fine platinum needle to various media. At first, these fragments were transferred to agar media which were suitable for the growth of the host but not for the parasite. To insure that only *D. cornuta* was present

in these cultures, they were kept under observation for at least ten days before transfers were made from them to different media. It was found that *Dispira* grew very meagrely on such agar media as malt, prune, etc., and produced gemmae by which the fungus was able to remain viable for weeks, in fact even until the agar was almost completely desiccated. Later when it was learned that *D. cornuta* was able to grow and sporulate as a saprophyte on certain media of high protein content as egg (PLATE 41, FIG. 1), swordfish and beef, it was transferred directly to these. Of these media, egg proved to be the most satisfactory both for growth and sporulation and for this reason it was used almost exclusively for the cultivation of this fungus. The egg medium (PLATE 41, FIG. 1) was prepared by beating together the whites and yolks of several raw eggs, then coagulating this mixture in the autoclave. After cooling, the resultant spongy mass was chopped into fine pieces, placed in suitable containers and sterilized.

While conducting these culture experiments it was observed that *Dispira* grew luxuriantly and sporulated abundantly on suitable media between 21° and 27° C., while at the lower temperatures of 8° and 10° C., or at higher temperatures around 35° C., it grew meagrely and failed to sporulate. Likewise it was found that spore germination occurred at the temperature range suitable for growth. Between 21° and 27° C., eighty-two per cent of the spores in hanging drops of 1.5 per cent proteose-peptone solution produced germ tubes 7-13 microns in length within five hours, while at 8° and 10° C. only four per cent of the spores produced germ tubes over a period of three days, and at 35° C. two per cent of the spores germinated and produced only short, abortive germ tubes.

In mounting the fungus for microscopical examination, Amann's lactophenol (6), with either acid fuchsin or cotton blue incorporated as stains, was found to be very useful because it did not cause plasmolysis of the fungus nor the retention of air bubbles around the parts to be examined. When the fungus was placed in water, it soon became flaccid and retained enough air bubbles to obscure the parts to be examined, although great care was exercised in the preparation of these mounts. The fertile hyphae of this fungus are covered with a substance, probably fatty in

nature, because they become black when exposed to solutions containing osmic acid. Perhaps for this reason they wet with difficulty.

RESULTS OF CULTURE EXPERIMENTS

Once the fungus was isolated as outlined above, its cultivation was attempted on various types of artificial media to determine the nutrients essential for the growth of this organism. The media used, their composition and preparation, the extent of the vegetative growth and of the sporulation of *D. cornuta* on these media are presented in the following table.

The extent of growth and of sporulation of *D. cornuta* has been expressed by such terms as "poor," "meagre," "fair," etc. Although it is realized that these terms fail to express the exact degree of development, still they are sufficient to convey to the reader some idea of the character of growth of this fungus upon the various media. An examination of this table shows the following points of interest.

(1) *Dispira cornuta* which was formerly considered to be an obligate parasite on members of the Mucorales, can be cultivated on certain artificial media derived from animal products. The media found suitable for the growth and sporulation of this fungus are egg in various forms, beef, swordfish, and to a certain extent rat dung.

(2) Although this fungus is a plant parasite, it will neither grow nor sporulate on such vegetable products as potato, bean pods, meats of Brazil nuts, cornmeal and oatmeal, which with the exception of Brazil nuts, are used commonly for the cultivation of plant parasites. In contrast to these results, Sawyer (8) found that *Entomophthora sphaerosperma* Fres. and *Empusa* sp., parasites on insects, grew on such common vegetable substances as beans, peas, potato and oatmeal besides on various animal products as egg yolk, meat, and different kinds of fish. Similarly, Lefebvre (7) reported the successful culture of *Beauveria Bassiana* (Bals.) Vuill. and *B. globulifera* (Speg.) Piccard, parasites on corn borer larvae, upon cornmeal, oatmeal and potato.

(3) *D. cornuta* can be cultured in such liquid media as aqueous solutions of peptone, proteose-peptone, nutrient broth and "Bacto-beef" infusion but will not sporulate in them. More-

over, when agar is added to these solutions, or even when solid rat dung is covered completely with agar, the fungus grows meagrely. Similarly Sawyer (8) observed that agar inhibited the growth of *Entomophthora sphaerosperma* and *Empusa* sp. when added to liquid media in which the fungi would normally grow. Agar, probably because of its physical nature retards or inhibits the growth of certain fungi.

(4) In liquid media containing only maltose, sucrose, lactose or dextrose, *Dispira* will not grow; therefore, it seems that sugars are not a source of food for this fungus. Furthermore, sugars are not required by this organism since it grows in media either lacking or containing minute traces of these substances.

(5) Apparently this fungus does not require fats for its metabolism, since it grew in media such as solutions of derived proteins (2) which at the most contain only very minute quantities of these substances, and it is unable to grow on cod liver oil or Mazola oil.

(6) Furthermore *Dispira* will not grow in liquid media containing complex nitrogenous compounds only, such as solutions of urea, asparagin and egg albumin. Obviously, it is necessary that such derived proteins as proteoses, peptone, peptids or polypeptids are in the medium as a source of food.

After being cultured for more than three years on artificial media *Dispira* is still able to parasitize the same members of the Mucorales as when it was first isolated. In contrast, certain parasites of the higher plants have been found to lose their pathogenicity after they have been cultivated in artificial culture for some time. Eddins (3), for example, observed that four multi-sporidial cultures of *Ustilago Zeae* (Beckm.) Ung. were unable to produce smut galls on corn after six subsequent transfers, while Edgerton et al (4) found that certain species of *Pythium*, after being cultivated for two years, could not infect their original hosts.

SUMMARY

(1) *Dispira cornuta* was isolated and cultivated on certain artificial media. The methods of isolation and culture are given, also the extent of growth and of sporulation on various media is tabulated.

TABLE I
GROWTH OF *DISPIRA CORNUTA* IN ARTIFICIAL CULTURE

Media used	Vegetative growth ^a	Coni-dial forma-tion ^a	Media used	Vegetative growth ^a	Coni-dial forma-tion ^a
<i>Agar media</i>					
"Difco" bean pod agar.....	x	—	Cod liver oil. Autoclaved.....	—	—
"Difco" nutrient agar.....	x	—	"Mazola" oil. Autoclaved.....	—	—
"Difco" nutrient agar plus horse dung.....	x	—	Dextrin, 1% aqueous solution.....	—	—
"Difco" nutrient agar plus rat dung.....	x	—	Lactose, 1% aqueous solution.....	—	—
"Difco" Sabouraud's dextrose agar.....	x	—	Sucrose, 1% aqueous solution.....	—	—
"Sabouraud's conservation" agar ("Difco" pro- teose peptone 1 part, agar 2 parts).....	x	—	Maltose, 1% aqueous solution.....	—	—
Malt agar (Synthetic) ^b	xx	x	Dextrose, 1% aqueous solution.....	—	—
Malt extract agar (3% malt extract).....	x	—	Urea, 1% aqueous solution.....	—	—
"Difco" cornmeal agar.....	x	—	Asparagin, 1% aqueous solution.....	—	—
"Difco" wort agar.....	x	—	"Difco" proteose-peptone, 1.5% aqueous solu- tion.....	xxx	—
Oatmeal agar.....	x	—	"Difco" proteose-peptone, 5.0% aqueous solu- tion.....	xxxxx	—
Oatmeal agar plus horse dung.....	x	—	"Difco" peptone, 1% aqueous solution.....	xxx	—
Potato agar.....	x	—	Nutrient broth.....	—	—
Potato-rat dung agar.....	x	—	10 gms. of peptone to 1000 cc. of hot but not boiling water. To this were added 4 gms. of beef extract.....	xxxxx	—
Potato-dextrose agar.....	x	—	Decoction of <i>Sporodinia</i> mycelium.....	—	—
"Difco" prune agar.....	x	—	"Difco" bacto-beef solution 5% aqueous solu- tion.....	xxxxx	—
"Difco" prune agar plus horse dung.....	—	—	Richards' solution ^c	—	—
Scales' whole egg agar ^c	xx	—			

Media used	Vegetative growth ^a	Conidial formation ^a	Media used	Vegetative growth ^a	Conidial formation ^a
<i>Plant products—No agar added</i>			<i>Animal products—No agar added</i>		
Rolled oats. Autoclaved.....	—	—	Egg (See Methods and Materials).....	xxxxx	xxxxx
Potato disks. Autoclaved.....	—	—	Egg yolk. Autoclaved.....	xxxxx	xxxxx
Potato disks, raw.....	—	—	Egg yolk, raw.....	xxxxx	xxxxx
Cornmeal (yellow). Autoclaved.....	x	—	Egg whites, raw.....	—	—
Meats of Brazil nuts. ^b (<i>Bertholletia excelsa</i> Humb. & Boupl.).....	—	—	Egg whites. Autoclaved.....	—	—
Mycelium ^b of <i>Mucor</i> sp. Autoclaved.....	—	—	Beef scraps. Autoclaved ^b	xxx	xx
Beans pods. ^b Autoclaved.....	—	—	Swordfish. ^b (<i>Xiphias gladius</i> L.).....	xxx	xxx
Mycelium of <i>Sporodinia</i> . ^b Autoclaved.....	—	—	Herring. ^b ((<i>Pomolobus pseudoharengus</i> Wilson). Horse dung. ^b Autoclaved.....	—	—
			Rat dung. ^b Autoclaved.....	xx	xx

^a Explanation of symbols: No growth = —; Trace = x; Meagre = xx; Fair = xxx; Good = xxxx; Luxuriant = xxxxx.

^b Indicates that the material was placed on moistened absorbent cotton.

^c Richards' Solution consisted of 10 grams of KNO₃, 5 grams of KH₂PO₄, 2.5 grams of MgSO₄, 20 mg. of FeCl₃, 50 grams of sucrose and 1000 cc. of distilled water.

^d Levine & Schoenlein. A Compilation of Culture Media. For the Cultivation of Micro-organisms. William & Wilkins, Baltimore, Md. 1930. Formula No. 1579.

^e Ibid. Formula No. 1957.

(2) Nutrient agar media were found to be unsuitable for the cultivation of *D. cornuta*; but on solid media as swordfish, meat and egg yolk, which are rich in certain proteins, it grows and sporulates satisfactorily.

(3) Liquid media containing only proteins, supported vegetative growth but not sporulation.

(4) Carbohydrates and fats either in liquid or solid media were unsuitable for the growth of the fungus.

(5) The optimum temperature for growth and sporulation and also for the germination of the spores is between 21° and 27° C., the minimum is near 8° C.; and the maximum temperature is about 35° C.

(6) *D. cornuta*, although it has been cultured for several years on various artificial media is still able to parasitize the same hosts as when first isolated.

LABORATORIES OF CRYPTOGAMIC BOTANY,
HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

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EXPLANATION OF PLATE 41

(1) *D. cornuta* growing as a saprophyte and sporulating on a medium consisting of the white and yolk of egg; (2) *D. cornuta* growing as a parasite on *Lymania* sp. The *Dispira* can be distinguished easily from its host by the chalky appearance of the sporophores and their dichotomous method of branching. 25 days old. $\times 1.6$ approx.; (3) *D. cornuta* on *Mucor* sp. which is growing on potato-rat dung agar. Note the dichotomous branching of the sporophores of *D. cornuta*. $\times 12$ approx.; (4) *D. cornuta* growing on *Pilobolus* sp. Note the manner of branching of the fertile hyphae and the distribution of the fertile heads on the foregoing branches. $\times 40$ approx.

NORTH AMERICAN HYPHOMYCETES. I. TWO NEW HELICOSPOREAE AND THE NEW GENERA HAPLOCHALARA AND PASPALOMYCES¹

DAVID H. LINDER

(WITH PLATE 42)

While going over collections made during the past several years, the writer discovered among his material several forms which do not agree with any of the species, and in some instances genera, that have as yet been published. Of these novelties, three will be described from material in the writer's herbarium, and one from the collection of Helicosporeae gathered by the late Professor Thaxter.

The first species is a beautiful one which superficially resembles *Helicoon fuscosporum* Linder,² but may readily be distinguished from it by the longer and more flexuous conidiophores, the conspicuous sporogenous teeth, and the stouter and less frequently coiled conidial filaments. Because of the conspicuous characters that separate it from other members of the genus, this species is described as new and is dedicated to the memory of the late Professor Roland Thaxter in recognition of his intense interest in the helicosporous Fungi Imperfecti.

Helicoon Thaxteri sp. nov. (PLATE 42, FIGS. 1-3.)

Coloniae effusae "Buffy Citrine" vel "Brownish Olive";³ conidiophoris 90-230 \times 2.7-4.5 μ , primum rectis deinde elongatis flexuosisque, parce ramosis, ramis elongatis et raro anastomosis, pellucidis, dilute fuscis vel ad cellulas extremas hyalinis, multiseptatis, septis atro-fuscis; dentibus sporigeris 2.5-3.5 \times 1.-2.5 μ , pleurogenis, hyalinis vel subhyalinis; conidia

¹ Contribution from the Cryptogamic Laboratory of Harvard University. No. 117.

² Linder, D. H. A monograph of the helicosporous Fungi Imperfecti. Ann. Missouri Bot. Gard. 16: 227-388, pl. 12-13. 1929.

³ Ridgway, R. Color standards and nomenclature, Washington, D. C., 1912, employed when color names are capitalized and placed within quotation marks.

primum hyalinis vel subhyalinis deinde fuscis vel brunneis, filis in helices elongato-ellipsoideas, (3-)-4-(5-) seriatas convolutis, ad septa atro-fusca constrictis, (5.4)-9 μ crassitudine, ad extrema exteriora rotundatis, ad bases fastigatis subhyalinisque; conidiis totis (23.5)-30.5-36-(41.5) \times (14.4)-19.8-(22) μ .

Colonies effuse "Buffy Citrine" to deep "Brownish Olive"; conidiophores 90-230 \times 2.7-4.5 μ , at first simple and erect or suberect, later becoming elongate and flexuous, sparsely branched below, the branches elongate and occasionally anastomosing, pellucid, dilute fuscous to hyaline or subhyaline at the terminal cells, frequently septate, the septa dark fuscous; sporogenous teeth 2.5-3.5 \times 1.5-2.5 μ , pleurogenous and scattered along the upper half of the conidiophore, stout, hyaline to subhyaline; conidia at first dilute fuscous becoming fuscous or brown with age, the filament 5.4-9 μ thick, constricted at the deep fuscous septa and coiled in three planes to form a (3-)-4-(5-) seriate elongate-ellipsoidal spore body, the apical cell abruptly rounded, the basal cell tapering to 1.5-2 μ at the point of attachment and hyaline to subhyaline; the coiled conidia (23.5)-30.5-36-(41.5) \times (14.4)-19.8-(22) μ .

On decaying wood, Cocanut Grove, Florida, R. Thaxter, TYPE.

The second fungus was collected in 1931 by the writer while he was collecting in Missouri. This, a species of *Helicoma* growing in association with *Xenospora larvalis* (Morg.) Linder, because of the shape, size, and number of septations of the conidia, closely resembles *Helicoma Curtisii* Berk. A careful comparison of the material with that which has been considered to be typical of *H. Curtisii* shows that there are certain points of difference. In the first place, the sterile repent mycelium as it grows over the surface of the substratum and matures, becomes, by the inflation of the cells between the septa, toruloid in aspect. Such bullate cells of the sterile mycelium are absent in *H. Curtisii*. In contrast to the latter species, the erect hyaline or subhyaline conidiophores when only at the 1-celled stage may bear conidia. Subsequently these immature conidiophores develop into the multiseptate and dark spore bearing structures. A more obvious difference between this species and *H. Curtisii*, is the presence of a large number of conidiophores, the terminal or subterminal cells of which are strikingly inflated. It was at first thought that these inflated cells, and the inflated cells of the sterile mycelium, were caused by some internal parasite but a study of a number of preparations

failed to reveal any structure that would indicate the presence of such a disturbing factor. Because of the differences between this form and its nearest ally, if such a term may be used in speaking of form-species, this species is deemed worthy of recognition and for it the binomial *Helicoma inflatum* is proposed.

***Helicoma inflatum* sp. nov. (PLATE 42, FIGS. 10-11.)**

Coloniae effusae, atro-brunneae vel atro-viridifuscae; myceliis sterilibus repentibus, ramosis, septatis, cellulis myceliorum superficialium saepissime forte inflatis; conidiophoris $18-119 \times 5-7 \mu$, primum hyalinis deinde fuscis vel sursum hyalinis, simplicibus, raro breve-ramosis, cellulis terminalibus vel subterminalibus denticulatis, saepe forte inflatis tum $8.5-12 \mu$ crassitudine, vel cellulis terminalibus pluries rotundato-fastigatis et non inflatis; dentibus sporigeris parvis, $1 \times 1 \mu$, hyalinis, persistentibus; conidiis hyalinis, acrogenis vel rarius pleurogenis, filis (4)-5-6-(7) μ diam., in $1\frac{1}{4}-1\frac{3}{4}$ spiras convolutis, (3-)-4-7-(8-) septatis, septis hyalinis, cellulis extremis abrupte rotundatis, cellulis basilaris rotundato-fastigatis apiculatisque; spiris $13.5-18 \mu$ diametro.

Colonies effuse, velvety, dark brown to very dark olive-brown; sterile mycelium repent, branched septate, and when growing on the surface of the substratum conspicuously inflated between the septa; young conidiophores when one- or two-celled hyaline to dilute fuscous, the older ones fuscous below but becoming hyaline at the apical cells, simple or very rarely short-branched, the terminal or subterminal cells denticulate, frequently inflated and $8.5-12 \mu$ thick at the widest part, or else not inflated and then rounded tapering at the apices, $18-119 \times 5-7 \mu$; sporogenous teeth hyaline, small, $1 \times 1 \mu$, persistent; conidia hyaline, acrogenous or rarely pleurogenous, $1\frac{1}{4}-1\frac{3}{4}$ times coiled, (3)-4-7-(8-) times septate, the septa hyaline; the filaments (4)-5-6-(7) μ in diameter with abruptly rounded terminal cells and rounded-tapering basal cells, truncate at the point of attachment; the coiled conidia $13.5-18 \mu$ in diameter.

On the inner side of bark on a prostrate oak log, near Valley Park, Missouri, April 5, 1931, Linder, TYPE.

The third fungus to be described belongs in the Dematiaceae-Didymosporeae near the genus *Beltramia*. It is so placed because in addition to the conidiophores it also produces erect sterile hyphae. It is these long, slender, flexuous, and deep fuscous sterile hyphae which form the loose dark cottony layer that makes the species so striking in spite of the fact that they extend far beyond the conidiophores and partially conceal the large number of yellow conidia. If the mycelium from which the sterile bristles

have arisen is traced in the superficial layers of the substratum, it will be found that it gives rise also to one or more conidiophores, each of which is composed of a slender rather elongate non-septate or few-septate stipe which, unlike that of *Beltramia*, is terminated by a succession of short, subhyaline or hyaline spore bearing cells. Each cell is provided with an apiculus or sporogenous tooth which projects at an angle and bears a single fragile chain of usually two elongate-ellipsoid, uniseptate spores. After the first spore or spore chain is produced, the cell continues its growth and elongates to form a second cell, but since the first spore was formed apically, the elongation is initiated at a point a little below the tip, thus forcing the sporogenous tooth to one side and making the original spore-bearing cells somewhat elbowed (PLATE 42, FIG. 4) so that they resemble somewhat the oogonia and antheridia produced serially by *Monoblepharis* of the Phycomycetes. The entire conidiophore when nearly devoid of its numerous conidia reminds one of the simple inflorescence found in certain species of the gramineous genus *Paspalum*. Because of this resemblance, and also because of the distinctive characters of the fungus, it is placed in the new genus *Paspalomyces* and designated as *Paspalomyces aureus*.

***Paspalomyces* gen. nov.**

Fungus myceliis repentibus, fuscis vel dilute fuscis, septatis ramosisque, hyphas steriles et conidiophora gerentibus; hyphis sterilibus longis, tenuibus, rectis vel adscendentibus flexuosisque, atro-fuscis; conidiophoris subhyalinis vel subfuscis, sursum hyalinis, cellis stipitis paucis, longis, cellulis sporigeris brevibus, paucis vel pluribus, lateraliter apiculatis et saepe geniculatis; conidiis ellipsoideis, uniseptatis, catenulatis.

Vegetative mycelium fuscous to light fuscous, septate, branched, producing both sterile hyphae and conidiophores; sterile hyphae long, slender, erect or ascending, and deep fuscous; conidiophores subhyaline to dilute fuscous with elongate basal cells surmounted by numerous short, acropetalously formed conidium bearing cells; conidia ellipsoid, light colored and uniseptate, and in chains.

***Paspalomyces aureus* sp. nov. (PLATE 42, FIGS. 4-6.)**

Coloniae "Olive Citrine" vel "Dull Citrine," stratum gossypinum hypharum elongatum gracilium flexuosarum formatum; hyphis sterilibus 250-400 \times 2.5-3.6 μ , sursum fastigatis ubi 1 μ diam.; conidiophoris 36-150 \times 1.8-2 μ (supra 3.6 μ diam.), dilute fuscis vel subhyalinis, pellucidis, simplicibus, rectis, infra paucis septatis (1-3), supra frequente septatis, cellulas hyalinas, 3.6 μ diam., unilateraliter et leniter bullatas formantibus; conidiis 9-11 \times 3.6-

4.5 μ , catenulatis, catenulis fragilibus plerumque sporarum duarum, citrinis vel subvitro hyalinis, elongato-ellipsoideis, uniseptatis et saepe ad septa leniter constrictis.

Colonies forming an "Olive Citrine" to "Dull Citrine" cottony layer of slender elongate flexuous hyphae; sterile hyphae 250–400 \times 2.5–3.6 μ , deep fuscous, simple, elongate, slender and flexuous, sparsely septate, tapering upward to 1 μ ; conidiophores 36–150 \times 1.8–2 μ , light fuscous to subhyaline, pellucid, simple, erect, few septate (1–3) below, closely septate above to form sporogenous cells that are 3.6 μ in diameter and mostly bulging at the base of the oblique sporogenous teeth; conidia 9–11 \times 3.6–4.5 μ , in fragile chains that are usually composed of two spores, yellow in mass, hyaline under the microscope, elongate-ellipsoid, 1-septate, frequently slightly constricted at the septa.

On maple bark, Canton, Massachusetts, August 1925, Linder, 1204, TYPE; on maple bark, Milton, Massachusetts, September 24, 1925, Linder, 1273.

The last fungus to be described was gathered in the early spring of 1928 near Louisville, Kentucky. It belongs in the tribe Chalariae Sacc. of the Dematiaceae-Amerosporeae in which Lindau⁴ places those species which produce conidia endogenously and in chains. As represented by *Thielaviopsis* and *Chalara*, among other genera, the species all produce their spores in chains and at least two or three spores are enclosed within the terminal cell of the conidiophore, although they may be forced out through the open apex of the cell when additional spores are formed. A modification of this method of spore production is shown by the fungus under discussion since the process is intermediate between the truly endogenous and exogenous types of spore formation. Although spore formation is initiated internally, by the time the spore has attained about half of its eventual dimensions, the upper part protrudes beyond the limits of the thick colored wall of the conidiophore (PLATE 42, FIG. 7), but it still remains within the hyaline, almost invisible, theca or outer layer. This hyaline outer layer is eventually ruptured by the enlarging spore and remains just below the apex of the conidiophore as an irregular transparent collar. Occasionally the collar persists and others are added by the successive formation of conidia. It is evident that sporulation is confined to the apical cells of the simple erect conidiophores, yet these

⁴Lindau, G., in Rab. Krypt.-Fl. 18: 747–760. 1906.

cells do not appear capable of unlimited production since conidiophores have been noted which have continued growth after a period of sporulation and have formed one or more sporogenous cells, indicated by local inflations of the fertile hyphae. Since the semi-endogenous method of spore production separates this form from all other members of the *Chalariae*, and in fact from other described genera of the Dematiaceae, it is placed in the new genus *Haplochalara*.

Haplochalara gen. nov.

Fungus myceliis sterilibus immersis, hyalinis vel subhyalinis, septatis; conidiophoris fuscis, rectis, simplicibus, septatis; conidiis hyalinis vel fuscis, primus internis deinde externis et catenulatis.

Sterile mycelium growing within the substratum, septate, hyaline or subhyaline; conidiophores fuscous, erect, simple; conidia 1-celled, hyaline or becoming fuscous with age, at first internal but later external and in chains.

Haplochalara angulospora sp. nov. (PLATE 42, FIGS. 7-9.)

Coloniae effusae atro-brunneae, strata hirsutula formantes; myceliis sterilibus immersis, septatis, hyalinis vel subhyalinis; conidiophoris $70-200 \times 4.5-5.5 \mu$, fuscis vel atrofuscis, simplicibus, septatis, cellulis aliquis infra vel supra inflatis; conidiis $6.5-7.5 \times 5-7 \mu$, rotundato-obconicis, primum internis deinde externis, catenulatis fuscescentibusque.

Colonies effuse, somewhat velvety, dark brown to almost black; sterile mycelium growing within the substratum, hyaline to subhyaline, septate, and giving rise to the dark brown or brown, simple, erect, septate conidiophores measuring $70-200 \times 4.5-5.5 \mu$ with some cells inflated either at the upper or lower end; conidia, $6.5-7.5 \times 5-7 \mu$, at first internal and hyaline but later become external, light fuscous, rounded-obconic, and catenulate.

On decaying beech log, near Louisville, Kentucky, March 23, 1928, Linder, TYPE.

As shown in plate 42, figure 8, an *Acrotheca*-like form was found growing with the species just described, and should be mentioned since if it should subsequently be shown that it is an exogenous phase, then *Haplochalara* would have to be classified along with the genera *Thielaviopsis* and *Chalaropsis* which also produce an exogenous spore-form. Unfortunately in this instance the conidiophores of both forms arise from mycelia that are imbedded in the woody substratum and since they are both light

colored it is difficult to determine with any degree of certainty whether the association is accidental or not. The occurrence of the exogenous form is by no means constant, nor can its appearance be correlated with the age of the colonies. In the middle and presumably more mature portions of the larger colonies the *Acrotheca*-like form may be absent or it may be present and even scandent on the conidiophores of *Haplochalara*. Although the question of the relation of the two forms is left open, it seems desirable to list the more important characters of this second form as follows: conidiophores simple from repent or scandent sterile mycelium, subhyaline, $10-18 \times 3-3.5 \mu$; the conidia fusoid, 2- to 3-septate, hyaline, $11-13.5 \times 2 \mu$.

The types of all specimens described in this paper have been deposited in the Farlow Herbarium of Harvard University.

EXPLANATION OF PLATE 42

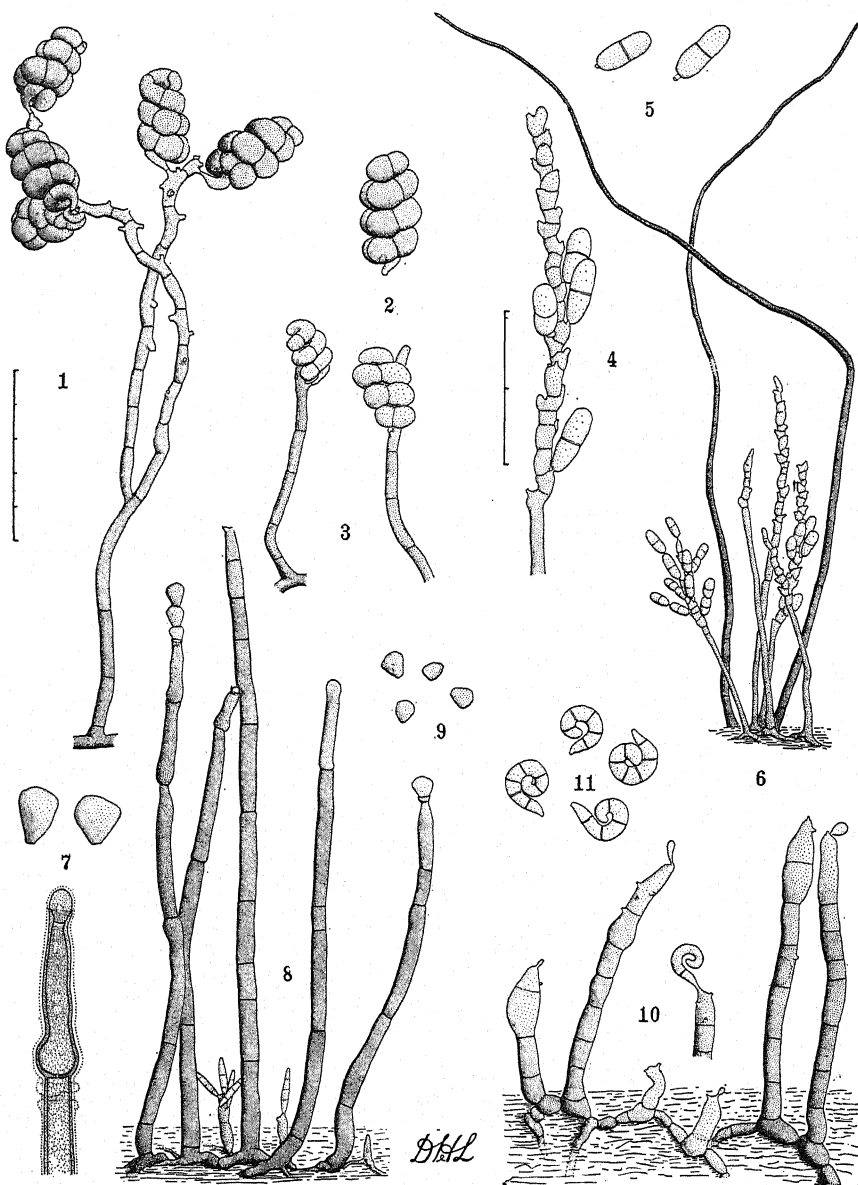
All drawings were made with the aid of a camera lucida from material mounted in lactophenol-cotton blue. Each division of the scale represents 10μ .

Helicon Thaxteri, figures 1-3. 1, A well developed conidiophore showing the characteristic loose branching and the numerous stout sporogenous teeth. $\times 500$; 2, A single mature conidium to show the 4-seriate helix, and the tapering subhyaline basal cell. $\times 500$; 3, Young erect conidiophores bearing the immature and subhyaline conidia. $\times 500$.

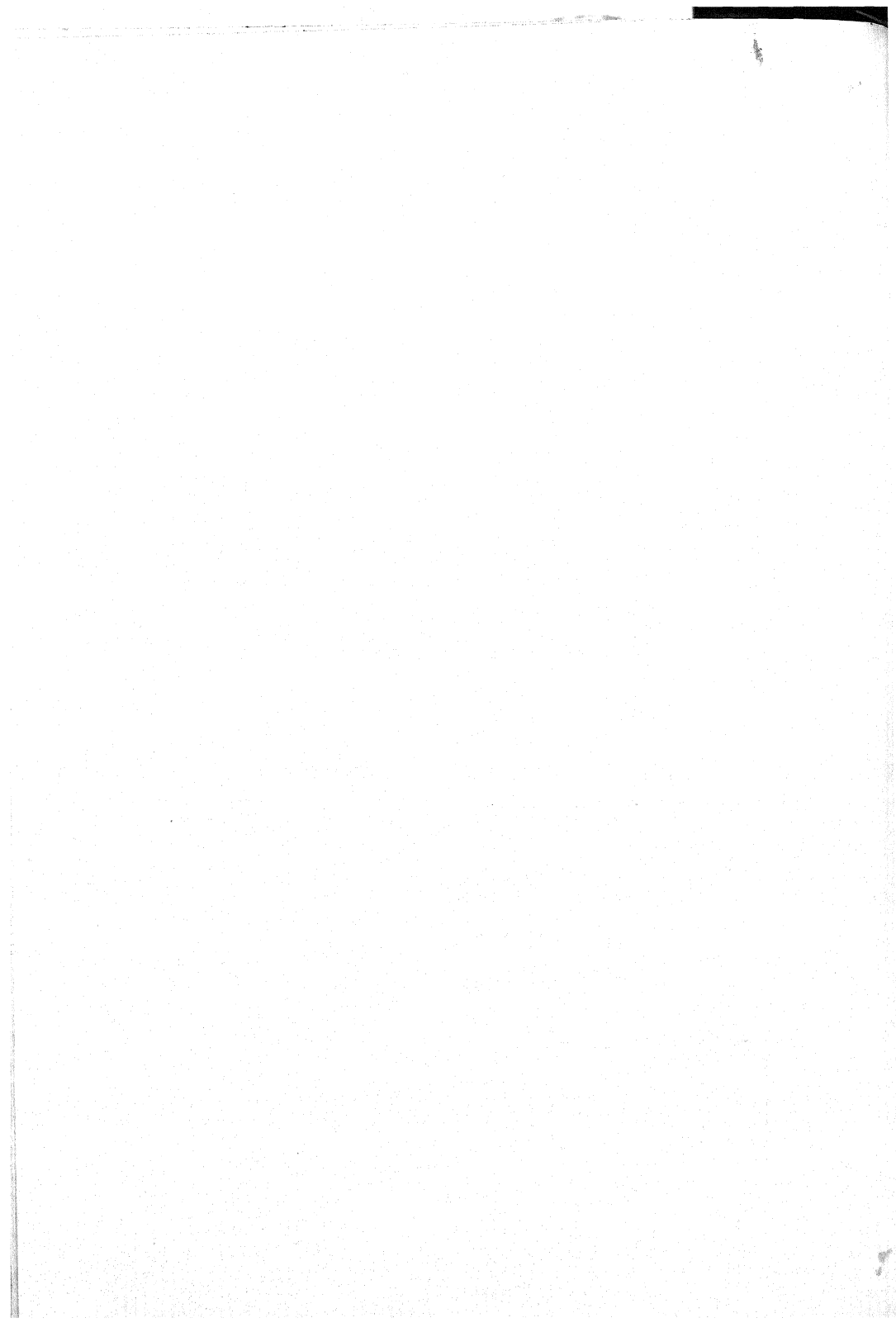
Paspalomyces aureus, figures 4-6. 4-5, Terminal portion of a conidiophore (fig. 4) to show the arrangement of the fertile cells and the spore-bearing teeth. The conidia (fig. 5) are frequently apiculate from the remnants of the sporogenous teeth. $\times 1125$; 6, A characteristic group of conidiophores with the accompanying long flexuous sterile hyphae. $\times 500$.

Haplochalara angulospora, figures 7-9; 7, Conidium and the tip of a conidiophore to illustrate the semi-endogenous type of spore formation found in this species. The hyaline theca that surrounds the spore and conidiophore should be observed. $\times 1125$; 8, A group of conidiophores showing various stages in spore production, also the swellings of the conidiophore which mark the points where sporulation has already taken place. At the base of the conidiophores may also be seen the *Acrotheca*-like form that is frequently present, but probably is not a definite phase in the life-history of *Haplochalara*. $\times 500$; 9, Several conidia to indicate variation in size and shape. $\times 500$.

Helicoma inflatum, figures 10-11. Conidia and conidiophores. In figure 10 are shown the bullate basal cells and the inflated terminal and subterminal cells of the conidiophores. The two erect 1-celled branches are immature conidiophores. $\times 500$.



HYPHOMYCETES



NEW AND RARE NORTH AND SOUTH AMERICAN USTILAGINALES¹

GEORGE L. ZUNDEL

Through the courtesy of Mr. J. A. Stevenson, U. S. Department of Agriculture, the author received for study, verification, and identification duplicate specimens of the smut collections of the late E. Bethel (*Reliquiae Bethelianaë*), collected in western United States, and also collections of unidentified smuts made in Brazil by Agnes Chase during 1929 and 1930. As a result of this study, five rare species and eight new species of smuts are considered worthy of being reported in this paper.

The Latin diagnoses of the new species were made by Dr. Robert E. Dengler, Professor of Classical Languages, the Pennsylvania State College. Dr. Dengler's interest in and connections with botany make him unusually well qualified for this type of work. His interest and willingness to coöperate are hereby acknowledged.

1. *USTILAGO PASPALI-DILATATI* P. Henn. in Brefeld. *Unters.* 12: 122. 1895.

On *Paspalum Urvillii* Steud., red clay, altitude 640-660 meters, Viçosa, Minas Geraes, Brazil, coll. Agnes Chase, Nov. 15-17, 1929. Plants of Brazil No. 10183½. This determination is only provisional until type material is available for comparison.

This smut has not been reported outside of Brazil. It was first collected on *Paspalum dilatatum* at Poiret, pr. Blumenau, Brazil.

2. *USTILAGO SCHRÖTERIANA* P. Henn. *Hedwigia* 35: 215. 1896.

On *Paspalum conspersum* Schrad., on dry black mud near streamlet, altitude 600-625 meters, São Miguel (northeast of Formiga), Minas Geraes, Brazil, coll. Agnes Chase, Jan. 9, 1930. Plants of Brazil No. 10541½.

On *Paspalum paniculatum* L., waste ground, altitude 600-625

¹ Contribution from the Botany Department, the Pennsylvania State College, No. 81.

meters, São Miguel (northeast of Formiga), Minas Geraes, Brazil, coll. Agnes Chase, Jan. 6, 1930. Plants of Brazil No. 10571.

The type locality of this smut is St. Catharina, Brazil. It has also been collected in Porto Rico. Type material was available for comparison with the collections above reported.

3. *Ustilago Goyazana* Zundel, sp. nov.

Sori in the ovaries completely destroying the inflorescence, surrounded by a delicate membrane, upon rupturing revealing a brown spore mass; spore globose or sub-globose, olive-brown, apparently smooth, but under oil immersion minutely echinulate, 3.5–5 μ diam.

On *Mesosetum loliiforme* (Hochst.) Chase, Goyandera, Goyaz, Brazil. Collected by Agnes Chase, March 26–27, 1930. Plants of Brazil No. 11555.

Soris in ovariis totam inflorescentiam destruentibus; membrana delicata ambiente; soris ruptis massa brunnea sporarum detecta; sporis atro-olivaceis, glabris at minute echinulatis, 3.5–5 μ diam.

Hab. in inflorescentia *Mesoseti loliformis* (Hochst), Chase, Goyandera, Goyaz, Respub. Brasil.; coll. Agnes Chase 26–27 Mart. 1930. Plants of Brazil No. 11555.

4. *Ustilago Bethelii* Zundel, sp. nov.

Sori in the leaves as striae ranging in length from a few cm. to nearly the entire length of the leaf, finally causing the leaves to become shredded; at first covered with a white membrane, but when ruptured disclosing a black spore mass; spores spherical to sub-spherical to ovoid, regular, dark reddish-brown, apparently smooth, but under oil immersion lens inconspicuously echinulate, 14–17 μ in diameter.

On *Muhlenbergia montana* (Nutt.) Hitch., Idaho Springs, Colorado. Collected by E. Bethel, Sept. 3, 1923.

Soris in foliis, in series longas a paucis centimetris usque ad folii longitudinem dispositis, foliis denique scissis; membrana soros primo celante postea rupta sporarum massam atram detegente; sporis globosis vel subglobosis vel ovoideis, regularibus, obscure rubro-brunneis, glabris at minute subechinulatis, 14–17 μ diam.

Hab. in foliis *Muhlenbergiae montanae* (Nutt.) Hitch., Idaho Springs, Colorado, in America septent.; coll. E. Bethel 3 Sept. 1923.

Four species of smuts have previously been described on *Muhlenbergia* sp. as follows:

- (1) *Ustilago mexicana* Ellis & Ev. has the sori in individual

spikelets of the inflorescence and smooth spores $5.5-8\mu$ diameter.

(2) *Ustilago Muhlenbergiae* P. Henn. has sori in the abortive inflorescence, with ovoid to spherical and granular echinulate spores $4-6\mu$ in diameter.

(3) *Sphacelotheca montaniensis* (Ellis & Holw.) Clinton has sori in the inflorescence and echinulate spores $12-15\mu$ in diameter.

(4) *Tilletia Muhlenbergiae* Clinton has sori in the inflorescence and winged reticulate spores $28-34\mu$ in diameter.

5. *Ustilago coloradensis* Zundel, sp. nov.

Sori in the leaves and leaf-sheaths, usually forming oblong-cylindric pustules, rounded at the ends, chiefly 1-5 mm. or apparently by terminal coalescence more elongate, at first firmly agglutinated, but eventually the thin membrane ruptures revealing a dusty spore-mass; spores dark reddish-brown, more or less irregularly polyhedral, occasionally oblong or ovoid to subspherical, smooth under oil immersion lens, $11-14\mu$ in diameter.

On *Muhlenbergia gracillima* Torr. Manitou, Colorado. Collected by E. Bethel, July 4, 1924.

Soris in foliis et vaginis foliorum, plerumque in pustulis oblongo-cylindricis dispositis, terminis rotundis 1-5 mm. vel per fusionem terminalem longioribus; primo firme agglutinatis, postremo, membrana tenui rupta, sporum massa pulverulenta detecta; sporis obscure rubro-brunneis, plus minus irregulariter polygonis, rarius oblongis vel ovoideis vel sphaeroideis, minute glabris, $11-14\mu$ diam.

Hab. in foliis vaginisque foliorum *Muhlenbergiae gracillimae* Torr. Manitou, Colorado, in America septent.; coll. E. Bethel, 4 Jul. 1924.

In general appearance this smut resembles *Ustilago Hieronymi* Schröt. on *Bouteloua* spp., but is separated by the smaller, smooth spores.

6. *Ustilago Pseudohieronymi* Zundel, sp. nov.

Sori on the leaves and leaf-sheaths, oblong cylindric, rounded at the ends, 1-3 mm. or by fusion longer. at first covered by a grayish colored membrane which when ruptured discloses a black spore mass; spores subspherical to ovoid, often somewhat angular, irregular, evidently echinulate, blackish-olivaceous, $14-18\mu$ in diameter.

On *Muhlenbergia squarrosa* (Trin.) Rydb., San Louis Valley, Colorado, collected by E. Bethel, June 27, 1921.

Soris in foliis et vaginis foliorum, oblongo-cylindricis, terminis rotundis, 1-3 mm. vel, post fusionem, longioribus; membrana obscure brunnea primo

tegente, deinde rupta massam atram sporarum detegente; sporis subglobosis vel ovoideis, saepe subangularibus irregularibusque, echinulatis, atro-olivaceis, 14–18 μ diam.

Hab. in foliis et vaginis foliorum *Muhlenbergiae squarrosae* (Trin.) Rydb., San Louis Valley, Colorado, in America septent.; coll. E. Bethel 27 Jun. 1921.

This smut is related to *Ustilago Hieronymi* Schröt. on *Bouteloua* spp. which it resembles very closely but is distinguished by the larger, more prominently echinulate spores.

Ustilago coloradensis Zundel, has smooth spores 11–14 μ diam. which distinguishes it from the above described species.

7. *Ustilago Festucae* Zundel, sp. nov.

Sori in the ovaries at first surrounded by a delicate membrane which when broken discloses a dark brown spore mass, completely destroying the ovary and base of the inner glumes, surrounded by outer glumes which rarely if ever are attacked; spores chiefly sub-spherical to spherical, light reddish-brown, lighter colored on one side, smooth under oil immersion lens, chiefly 3.5–5 μ , rarely 7 μ in diameter.

On *Festuca Kingii* Cassedy, Fort Collins, Colorado, collected by E. Bethel, July 29, 1905.

Soris in ovariis, membrana delicata primo ambiente, deinde rupta sporarum massam atro-brunneam detegente, ovario atque glumarum interiorum baside prorsus destructis, glumis exterioribus rarius vel numquam affectis; sporis globosis vel subglobosis, dilute rubro-brunneis, ex alia parte dilutioribus, minute glabris, 3.5–5 μ , rarius 7 μ diam.

Hab. in ovariis *Festuae Kingii*, Cassedy, Fort Collins, Colorado, in America septent.; coll. E. Bethel 29 Jul. 1905.

Of the five species of smuts previously described on *Festuca* spp. all of them have larger spores and none have smooth spores.

(1) *Ustilago Mulfordiana* Ellis & Ev. has the sori in the inflorescence often destroying outer basal parts; spores are obscurely verruculose, 12–16 μ diam.

(2) *Ustilago striaeformis* (Westend) Niessl, has the sori as striae on the leaves, rarely attacking the inflorescence, spores are prominently echinulate, 9–14 μ diam.

(3) *Ustilago sphaerocarpa* Sydow, has the sori destroying the ovary, spores are densely verruculose, 15–18 μ diam.

(4) *Tilletia Vulpiae* P. Magn. has the sori destroying and occupying the ovary, spores dark, ellipsoidal, reticulate, 19–17 μ diam.

(5) *Tilletia fusca* has the sori in the ovary, spores reticulated showing as blunt projections on the circumference, 20–25 μ diam.

8. *Sphacelotheca columellifera* (Tul.) Ciferri, Ann. Myc. 26: 32. 1928.

Ustilago carbo columellifera Tul. Ann. Sci. Nat. III. 7: 82. 1847.

On *Trachypogon canescens* Nees, campo, altitude 700–725 meters, Casa Branca, São Paulo, Brazil, coll. Agnes Chase, Jan. 16, 1930. Plants of Brazil No. 10598½.

On *Trachypogon mollis* Nees, open campo summit, altitude 1,100–1,500 meters, Poços de Caldas, Minas Geraes, Brazil, coll. Agnes Chase, Jan. 18–20, 1930. Plants of Brazil No. 10628, also Buritys, near Rio São Francisco, Minas Geraes, Brazil, coll. Agnes Chase, Jan. 1, 1930. Plants of Brazil No. 10452½.

On *Trachypogon Montufari* (H.B.K.) Nees, sandy campo, altitude 300–325 meters, Tres Lagoas, Motto Grasso, Brazil, coll. Agnes Chase, Feb. 4–5, 1930. Plants of Brazil No. 10721½.

This is the first report of this smut from South America. Previously the smut has been reported on *Andropogon* spp. from Algeria, Australia, Madeira Islands, and Tanganyika Territory.

9. *Sphacelotheca Trachypogonis* Zundel, sp. nov.

Sori in the ovaries long linear about 2–3 cm. long, covered by a delicate yellowish membrane which ruptures revealing a dark brown granular spore mass and a well formed columella; spores dark brownish-black, spherical to ovoid, dense, covered with prominent irregular scale-like tubercles, 10–14 μ diam., averaging about 11 μ ; sterile cells abundant through the sorus, singly or in groups of two or three, irregular, with a thick hyaline wall and sometimes with yellowish contents.

On *Trachypogon vestitus* Anderss, Campo Grande, Matto Grosso, Brazil. Collected by Agnes Chase, Feb. 7–10, 1930. Plants of Brazil No. 10826.

Soris in ovariis, linearibus, 2–3 cm. longis, membrana subflava et delicata tectis, massa atro-brunnea granularique sporarum et distincta columella ex rupta membrana apparentibus; sporis obscure atro-brunneis, globosis vel ovoideis, densis, conspicua irregularia squamosaque tubercula porrigentibus, 10–14 μ diam. plerumque 11 μ ; cellis sterilibus et per sorum abundantibus, singulis vel binis vel ternis, irregularibus, densis, hyalinis, rarius subflavis.

Hab. in ovariis *Trachypogonis vestiti* Anderss, Campo Grande, in Provinc. Matto Grosso, in Republ. Brasil.; coll. Agnes Chase, 7–10 Febr. 1930. Plants of Brazil No. 10826.

10. *Sphacelotheca Andropogonis* (Opiz) Bubak, Naturw. Landes. Böhmen 15: 25. 1916.

Uredo (Ustilago) Andropogi Opiz, Naturalien. 1823-24: 43. 1823.

Sphacelotheca Ischaemi Clinton, Jour. Myc. 8: 140. 1902.

On *Andropogon goyazensia* Hack., wet vargem, Santo Rita do Araguaya, on Rio Araguaya, Motto Grasso, Brazil, coll. Agnes Chase, April 5-6, 1930. Plants of Brazil No. 11854.

On *Andropogon Salzmannii* (Trin.) Hack., moist gravelly campo, 4-5 kilometers west of Diamantina, Serra de San Antonio, Minas Geraes, coll. Agnes Chase, Dec. 27-30, 1929. Plants of Brazil No. 10419½.

This is apparently the first report of this smut from South America.

11. *Sphacelotheca Macrothricis* Zundel, sp. nov.

Sori destroying the floral parts, long linear, 4-5 mm. long, covered with a yellowish-brown membrane which flakes away revealing a dark brown spore mass surrounding a well formed columella; sterile tissue easily breaking up into sterile cells, either singly or in pairs, occasionally in chains, variable in shape but usually irregularly ellipsoidal, hyaline, with walls tinted yellow, 7-14 μ diam.; spores regular, globose to subglobose, olive brown, apparently smooth but under oil immersion abundantly echinulate, 7-14 μ diam.

On *Andropogon macrothrix* Trin., Uberlandia (Uberabinha), Minas Geraes, Brazil. Collected by Agnes Chase, March 15, 1930. Plants of Brazil No. 11253½.

Soris inflorescentiam destruentibus, linearibus 4-5 mm. longis et membrana flavo-brunnea tectis; membrana rupta massam sporarum atro-brunneam columellam distinctam ambientem detegente; cellis sterilibus, singulis vel binis, rarius catenatis, forma mutabilibus, plerumque irregularibus, ellipsoideis, hyalinis, sub-flavis; 7-14 μ diam.; sporis irregularibus, globosis vel subglobosis, olivo-brunneis, glabris at minute echinulatis, 7-14 μ diam.

Hab. in inflorescentia *Anthropogonis macrothricis*, Uberlandiae (Uberabinha), Provinc. Minas Geraes, Republic. Brasil.; coll. Agnes Chase 15 Mart. 1930. Plants of Brazil No. 11253½.

This smut in general appearance resembles *Sphacelotheca occidentalis* (Seym.) Clint. but differs in having more regular, smaller, olive-brown spores.

12. *Sphacelotheca inconspicua* Zundel, sp. nov.

Sori destroying the inflorescence, hidden by the glumes, 2-3 mm. long, covered by a brown delicate membrane which flakes away revealing a brownish spore mass and a well developed columella; sterile cells hyaline, single or in groups about the size of the spores; spores reddish-brown, irregular globose-ellipsoidal, sometimes angled, smooth, 7-10 μ diam.

On *Mesosetum loliforme* (Hochst.) Chase, vicinity of Goyaz City, Goyaz, Brazil; coll. Agnes Chase, March 20-22, 1930. Plants of Brazil No. 11464; on *Anoxopus marginatus* (Trin.) Chase, Rio Verde (17° 40' South 51° West) Goyaz, Brazil, collected by Agnes Chase, April 2, 1930. Plants of Brazil No. 1170½.

Soris inflorescentiam destruentibus; glumis celantibus; soris 2-3 mm. longis et membrana brunnea delicataque tectis quae in squamas disrupta massam sporarum brunneam et columellam distinctam detegit; cellis sterilibus hyalinis, singulis vel in globo sporarum fere magnitudinem habente distributis; sporis rubro-brunneis, globoso-ellipsoideis, irregularibus, rarius angulatis, glabris, 7-10 μ diam.

Hab. in inflorescentia *Mesoseti loliformis* (Hochst.) Chase prope urbem Goyaz, Provinc. Goyaz, Respub. Brasil.; coll. Agnes Chase 20-22 Mart. 1930. Plants of Brazil No. 11464; in inflorescentia *Anoxopi marginati* (Trin.) Chase, Rio Verde (17° 40' austr., 51° occid.) Goyaz, Respub. Brasil.; coll. Agnes Chase 2 Apr. 1930. Plants of Brazil No. 1170½.

13. UROCYSTIS BORNMULLERI P. Magn. Deuts. Bot. Gessell. 30: 290-293. 1912.

On *Melica imperfecta* Trin., California, Coll. E. Bethel, 1919 (Reliquiae Betheliana).

This determination is provisional until the type specimen can be located for comparison. It is at least close to *Urocystis Bornmulleri* P. Magn. having oblong to spherical spore balls 20-42 μ in length, completely surrounded by brownish tinted sterile cells. Spore balls usually contain 3-4 (rarely 2-2) reddish-brown spores measuring 14-18 μ in length.

Urocystis Agropyri (Preuss) Schröt., the only other *Urocystis* reported on *Melica* sp., has oblong to subspherical spore balls 16-32 μ in length that are completely surrounded by hyaline to yellowish sterile cells. Each spore ball consists of 1-2 (rarely 3-4) reddish-brown spores measuring 11-18 μ in length.

THE HYDNACEAE OF IOWA. I. THE GENERA GRANDINIA AND OXYDONTIA

L. W. MILLER

(WITH PLATE 43)

The fungi here described were all collected in Iowa with the single exception of *Grandinia granulosa* Fries. These have more than local interest since the occurrence of several species has apparently not previously been reported from the United States. The published records of resupinate species of the Hydnaceae in this country, however, are not believed to be a fair index of their frequency or distribution. Many of the little known species are common in Iowa. The vast collections of undetermined material in our larger herbaria indicate the widespread occurrence of these fungi and the need for study of the group.

A key to the genera of the Hydnaceae and a brief taxonomic discussion of *Grandinia* and *Oxydontia* may be found in a previous paper (Mycologia 25: 286-302. 1933).

GRANDINIA Fries, Epicr. 527. 1838.

Texture variable; warts minute, fragile; hyphae and spores pale or hyaline. This genus differs from *Oxydontia* chiefly in the minute warts.

KEY TO THE SPECIES OF GRANDINIA

1. Subhymenium bearing antler-like, dichotomously branched, thick-walled structures 2. *G. granulosa*.
1. Hyphae not antler-like, relatively thin-walled (2)
 2. Spores minutely but distinctly echinulate 4. *G. farinacea*.
 2. Spores smooth, rarely slightly roughened (3)
3. Basidia with 4-6-8 sterigmata; spores cylindrical or fusiform (4)
3. Basidia with 2-4 sterigmata; spores subspherical or elliptical (5)
 4. Hyphae and basidia guttulate; spores $7-8 \times 3-4 \mu$... 6. *G. raduloides*.
 4. Hyphae and basidia not guttulate; spores $3-5 \times 2-3 \mu$ 5. *G. Brinkmanni*.
5. Fructification separable; teeth hemispherical, collapsing in drying 1. *G. helvetica*.
5. Fructification adnate; teeth hemispherical to short cylindrical, with obtuse crests, not collapsing in drying 3. *G. mutabilis*.

1. *GRANDINIA HELVETICA* (Pers.) Fries, Hymen. Europ. 627. 1874. (PLATE 43, FIG. 6)

Hydnum helveticum Pers. Myc. Europ. 2: 184. 1825.

Corticium tomentelloides Höhn. & Litsch. Sitz. Akad. Wiss. Wien 116: 824. 1907.

Fructification resupinate, effused, thin, separable, floccose-mealy, with a subceraceous hymenial pellicle supported on a loose fibrillose subiculum, stretching in drying and breaking in places, cream color; margin fibrillose, the fibrils branching and running over the substratum; warts hemispherical or dome-shaped, giving to the hymenial surface a colliculose appearance, considerably flattened in drying; hyphae $3.5-7\ \mu$ in diameter, not incrustated, thin-walled, with scattered clamp connections, forming rope-like strands, $7-20\ \mu$ in diameter, which run over the substratum; basidia $15-30 \times 5-7\ \mu$, short, thick, with 4 sterigmata; spores $3.5-5\ \mu$, spherical or sub-angular, smooth, hyaline, 1-guttulate.

This species is recognized by its thin, soft, separable membrane, the colliculose hymenium and the slender, branching fibrils. It resembles certain of the thin, membranaceous species of *Corticium*, approaching closely to *Corticium arachnoideum* Berk.

Collected once in Iowa in December, 1931. No report of its occurrence in the United States has come to my attention. However, a specimen of this species labeled *Grandinia membranacea* Ellis & Ev. from Canada, collected by Macoun in 1898, was found in the mycological herbarium of The New York Botanical Garden. Our specimen was carefully compared with specimens determined by Bourdot and by Miss Wakefield and agrees well with the description of the type by Bourdot (1932).

2. *GRANDINIA GRANULOSA* Fries, Epicr. 527. 1838. (PLATE 43, FIG. 4)

Asterostromella granulosa (Fries) Bourd. & Galz. Hymén. Fr. 396. 1928.

Fructification resupinate, effused, adnate, thin, subceraceous or crustaceous, slightly pruinose, not cracking, warm buff to cinnamon-buff; margin similar; warts hemispherical, crowded; hyphae $3-5\ \mu$ in diameter, dichotomously branched and antler-shaped, with thick walls, subhymenial hyphae indistinct; basidia $14-20 \times 4-5\ \mu$; spores $5-6 \times 3.5-4\ \mu$, ellipsoid, smooth, hyaline.

This species is characterized by the numerous thick-walled, antler-shaped hyphal structures. This character is made diagnostic for the genus *Asterostromella* Höhn. & Litsch. Apparently the subhymenial hyphae accompanying the specialized hyphae are thin-walled and very fragile or undergo some transformation, since they always appear indistinct under the microscope.

G. granulosa Fries apparently has never been collected in Iowa but is included here since the state lies within its geographic limits. This description is given also in order to show its relationship to *Grandinia mutabilis* to which the same specific name has occasionally been applied. *G. granulosa* is reported from scattered localities in the eastern United States, but it is doubtful whether in every case the reports refer to the same species as here described. Only a small number of the forty or fifty specimens labeled *G. granulosa* at The New York Botanical Garden were determined correctly.

3. *GRANDINIA MUTABILIS* (Pers.) Bourd. & Galz. Bull. Soc. Myc. Fr. 30: 250. 1914. (PLATE 43, FIG. 5)

Hydnum granulosum var. *mutabile* Pers. Myc. Europ. 2: 184. 1825. non *G. granulosa* Fries.

Odontia olivascens Bres. Fungi Trid. 2: 36. 1892.

Corticium sulphurellum Höhn. & Litsch. Oest. Cort. 66. 1907.

Odontia mutabilis (Pers.) Bres. Ann. Myc. 9: 426. 1911.

Grandinia granulosa (Pers.) Bourd. & Maire, Bull. Soc. Myc. Fr. 36: 74. 1920.

Grandinia Abrotani Vel. Ceské houby 734. 1922. (fide Cejp)

Fructification resupinate, effused, adnate, very thin, ceraceous, not cracking, whitish to tilleul-buff, becoming at times isabelline or greenish in the herbarium; margin similar or pruinose; warts more or less uniformly hemispherical to short cylindrical, very fragile, scattered to crowded, occasionally few or absent; hyphae 3–6 μ , irregularly branched, with occasional clamp connections, not incrustated; basidia 15–20 \times 6–7.5 μ , clavate; spores 4–5.5 \times 3.5–4.5 μ , subspherical, smooth, rarely slightly roughened, apiculate, hyaline.

The thin, ceraceous fructification, the undifferentiated margin and the uniform, obtuse warts, which do not collapse upon drying, are useful characters in the determination of this species.

Thelephora granulosa was described by Persoon in 1801. In

1825 he transferred it to the genus *Hydnum* and recognized several varieties. Form *mutabile*, according to Bourdot and Maire (1920), applied to specimens that have become "jaunissant ou verdissant" in the herbarium. Donk (1930) and Bourdot (1932), however, indicate that *mutabile* and *granulosa* Pers. do not represent the same species. *Grandinia granulosa* Fries is based on a species having a similar fructification but differing sharply in the possession of antler-shaped or dichotomously branched structures in the context and trama. *G. granulosa* (Pers.) Bourd. & Maire and *G. granulosa* Auct. also appear in literature. If Fries's species is to be regarded as a *Grandinia* it seems that the specific name *granulosa* should be retained for his species since he was first to employ it in this genus.

Collected once on deciduous wood near Milford, Iowa, Aug. 8, 1931. No report of the occurrence of this species in North America has come to my attention. A specimen in the Ellis collection in The New York Botanical Garden, labeled *Grandinia membranacea* E. & E., on dead wood, 30/10/98, is *Grandinia mutabilis* as here understood.

4. *GRANDINIA FARINACEA* (Fries) Bourd. & Galz. Bull. Soc. Myc. Fr. 30: 253. 1914. (PLATE 43, FIG. 2)

Hydnum farinaceum Pers. ex Fries, Syst. Myc. 1: 419. 1821.

Hydnum niveum Pers. ex Fries, Syst. Myc. 1: 419. 1821.

Odontia nivea (Fries) Quél. Fl. Myc. Fr. 435. 1888.

Odontia farinacea (Fries) Bres. Atti Accad. Rovereto III. 3: 99. 1897. *non* Quélet. 1888.

Resupinate, effused, adnate, very thin, arachnoid under the lens, soft membranaceous, pruinose, white to light buff; margin byssoid or pruinose, white; teeth 2 mm. or less in length, crowded, slender, subulate, fragile, terminating in a bundle of sterile hyphae; trama with calcium oxalate crystals; hyphae 2-4 μ in diameter, fragile, with clamp connections, occasionally swollen at the septa; basidia 12-24 \times 3-5 μ , clavate, with 2-4 sterigmata; spores 3-4 \times 2.5-4 μ , subspherical, minutely echinulate, hyaline.

This species closely resembles *Grandinia Brinkmanni* in color and texture but is readily distinguished by the subspherical echinulate spores. The subulate spines terminated by sterile hyphae and

the powdery masses of conidia which frequently occur on or near the margin of the fructifications offer additional distinctive characters. It may at times be recognized in the field by the latter character. The teeth in Iowa specimens usually do not exceed 1 mm. in length.

Common in Iowa on much decayed coniferous and deciduous wood; collected in all seasons, mostly from April to November. Cejp (1931) first reported it from Iowa. Its occurrence has been reported also from scattered localities in the central and eastern United States. The many specimens under several different names in the Farlow Herbarium, at The New York Botanical Garden and at the University of Iowa indicate that it is fairly common throughout the eastern United States.

5. *GRANDINIA BRINKMANNI* (Bres.) Bourd. & Galz. Bull. Soc. Myc. Fr. 30: 252. 1914. (PLATE 43, FIG. 3)

Odontia Brinkmanni Bres. Ann. Myc. 1: 88. 1903.

Grandinia crustosa Vel. České Houby. 734. 1922. (fide Cejp.)

Fructification resupinate, effused, adnate, very thin, sub-crustaceous, arachnoid under the lens, pruinose, pale smoke gray to nearly white; margin pruinose or minutely fibrillose; teeth 1 mm. or less in length, very fragile, varying from obtuse warts to short, acute teeth, sometimes absent in small areas as in *Corticium*; context with calcium oxalate crystals; hyphae $2-4\ \mu$ in diameter, fragile, indistinct; basidia $10-12-24 \times 3-6\ \mu$, clavate or urn-shaped, with 4-6-8 sterigmata; spores $3-5 \times 2-2.5\ \mu$, short cylindrical, slightly curved, smooth, hyaline.

This species is recognized by its thin, whitish, arachnoid subiculum, minute warts and its urn-shaped basidia, often with 6-8 sterigmata. It seems related to certain of the thin forms of *Corticium*, as *C. calceum* Fries and *C. octosporum* Schröt.

This description differs from the original description in the recognition of urn-shaped basidia, a character also observed by Bourdot and Galzin, and in noting that the spores are curved. Bresadola described the basidia as clavate. The basidia in my specimens are at first obovate then develop into the typical basidia which have slightly swollen bases and cylindrical or clavate pro-

longations. Bresadola describes the spores as being cylindrical but does not point out that they are curved. A greater range in spore size is given by Bourdot and Galzin, $3-4.5-6 \times 1.5-3 \mu$. The teeth in my specimens do not exceed 0.5 mm. in length. Bresadola indicates that they may become twice as long. This character, however, seems to be quite variable. Iowa specimens agree well with a specimen from Bresadola's herbarium at The New York Botanical Garden and several specimens from Bourdot at the Farlow Herbarium and in the C. G. Lloyd Mycological Collection.

Fairly common in Iowa. Collected from March to December on very much decayed, coniferous and deciduous wood. No report of its previous occurrence in the United States has come to my attention. However, an undetermined specimen from New Jersey and one from Ohio was found at the New York Botanical Garden.

6. *GRANDINIA RADULOIDES* (Karst.) Bourd. & Galz. Hymén. Fr. 412. 1928. (PLATE 43, FIG. 1)

Hydnum raduloides Karst., Medd. Soc. Faun. Fl. Fenn. 9: 110. 1883.

Effused, soft, floccose-pruinose, adherent, white to pale pinkish buff; margin similar; teeth 1.5 mm. or less in length, cylindrical or subulate, rounded at the apex, pruinose, with reddish tint when dry; hyphae $3-5 \mu$ in diameter, thin-walled, guttulate, with clamp connections, more densely compacted in the teeth than in the base of the fructification; context with large, scattered, calcium oxalate crystals; basidia $15-25 \times 5-8 \mu$, urn-shaped, guttulate, basal portion swollen, with 6-8 prominent sterigmata; spores $7-8 \times 2.75-3.5 \mu$, fusiform, smooth, hyaline.

This fungus resembles *Grandinia Brinkmanni* and *Grandinia muscicola* (Pers.) Bourd. & Galz. in the possession of urn-shaped basidia with 6-8 sterigmata. It is quite readily separated from these by its soft, floccose-pruinose texture, guttulate tramal hyphae and basidia, and by its larger spores.

Grandinia raduloides appears to be rare in this country. Bourdot and Galzin report a specimen from the United States received from C. G. Lloyd (no. 1444). No trace of this species was found in the Lloyd herbarium at Washington, D. C. It was collected

once in 1931 on a fallen and decorticated, frondose limb near Estherville, Iowa, which seems to be the only other record from the United States.

OXYDONTIA Miller, Mycologia 25: 294. 1933.

Floccose to ceraceous, adnate or separable; teeth or spines relatively large and distinct; hyphae and spores hyaline, pale or bright colored.

KEY TO THE SPECIES OF OXYDONTIA

1. Fructification separable; hymenium light buff when fresh; spores sub-spherical, about $5 \times 4 \mu$ 4. *O. macrodon*.
1. Fructification adnate or separable; hymenium darker than light buff; spores elliptical to sub-cylindrical(2)
2. Fructification strongly adnate; context compact throughout; mycelial strands absent(3)
2. Fructification separable or with a loose, floccose layer next to the substratum; margin usually with mycelial strands running over the substratum(4)
3. Fructification bright yellow in color, with a strong odor when fresh; spores $5-6 \times 3-4.5 \mu$; restricted to pomaceous hosts5. *O. setosa*.
3. Fructification mars yellow to mars brown; odor not pronounced; spores $3-5 \times 1.5-2.5 \mu$; on wood of various species6. *O. stenodon*.
4. Fructification separable, bright orange in color; spores $3.5-4.5 \times 2-2.5 \mu$ 3. *O. fragilissima*.
4. Fructification adnexed to the substratum by a loose, floccose layer, white to dark olive buff or avellaneous; spores $7-12 \times 3.5-5 \mu$..(5)
5. Hymenium dark olive-buff; hyphae smooth; spores roughened, dark olive-buff1. *O. albobiride*.
5. Hymenium avellaneous; hyphae often faintly roughened; spores smooth, hyaline2. *O. Himantia*.
1. OXYDONTIA ALBOVIRIDE (Morg.) Miller, Mycologia 25: 294. 1933. (PLATE 43, FIG. 12)

Hydnum albobiride Morg. Jour. Cinc. Soc. Nat. Hist. 10: 12. 1887.

Fructification resupinate, widely effused, 600–800 μ in thickness, consisting of a very loose, floccose, white subiculum which is usually not covered by a hymenium; margin similar or rhizomorphic; spines 2 mm. in length, terete, subulate, pointed, usually sterile at the apex, at first white, then dark olive-buff; hyphae 1.5–5 μ in diameter, loosely interwoven in the subiculum, with numerous clamp connections, smooth; basidia 20–30 \times 3.5–5 μ , clavate, with 4 sterigmata; spores 7–10 \times 3–4 μ , fusiform, attenuated and slightly curved at one end, roughened, dark olive-buff.

This species is recognized by its loose, floccose subiculum and the dark olive-buff, roughened spores. It has often been confused with *Hydnum Himantia* Schw. from which it may readily be separated by the smooth hyphae and the colored, roughened spores.

Three specimens were collected in Iowa; early April to October. Apparently uncommon. It seems to have been reported only from Ohio. However, specimens of this species collected in Massachusetts, Indiana, Connecticut, New York and Sweden (Romell) were examined at The New York Botanical Garden. The type is probably destroyed. An authentic specimen collected by Morgan in 1888 in the mycological herbarium of the University of Iowa undoubtedly represents the true *Hydnum alboviride* Morg. I have not seen the type or an authentic specimen of *Hydnum byssinum* but strongly suspect it is Schweinitz's name for the same species.

2. OXYDONTIA HIMANTIA (Schw.) Miller, Mycologia 25: 294. 1933. (PLATE 43, FIG. 11)

Hydnum Himantia Schw. Schr. Nat. Gez. Leipzig 1: 104. 1822.

Hydnum subfuscum Peck, Ann. Rep. N. Y. State Mus. 40: 55. 1887.

Odontia himantia (Schw.) Bres. Ann. Myc. 1: 84. 1903.

Fructification resupinate, widely effused, consisting of a waxy, pelliculose hymenial layer which is avellaneous in color and 50–200 μ in thickness, and a loose, floccose, white layer next to the substratum, 200–1000 μ in thickness, sometimes with large areas of white, cottony mycelium not covered by a hymenium; margin floccose or fibrillose and with white, rhizomorphic strands running over the substratum; spines 6 mm. or less in length, terete, subulate, pointed or obtuse; hyphae 2–4 μ in diameter, faintly roughened, with numerous clamp connections, often swollen at the septa, with scattered masses of crystalline material; basidia 25–40 \times 6–8.5 μ , with 2–4 long sterigmata; spores 10–12 \times 3.5–4.5 μ , cylindrical-ellipsoid, attenuated at one end, smooth, granular or guttulate, hyaline.

The loose, floccose subiculum covered in places by a waxy pelliculose layer, the rhizomorphic strands, the roughened hyphae often swollen at the septa and the large spores are diagnostic characters

for this species. The hymenium of a young fructification may be confined entirely to the spines in which case the white cottony subiculum gives the specimen the aspect of *Oxydontia alboviride*. These two species have been confused in this country. They can be separated readily by the color of the hymenium and the spore and hyphal characters. *Hydnum alboviride* has dark olive-buff, roughened spores and smooth hyphae.

This species occurs on much decayed wood from April to December and apparently is an active wood rotting form. One luxuriant growth was observed covering the lower side of a fallen limb for an estimated distance of 20 feet. It is common in Iowa and apparently widely distributed in the United States. I have examined specimens from eleven states, including several from the west coast. The types of *Hydnum subfuscum* Peck and *Hydnum Himantia* Schw. have been studied.

3. OXYDONTIA FRAGILISSIMA (Berk. & Curt.) Miller, Mycologia 25: 294. 1933. (PLATE 43, FIG. 8)

Hydnum fragilissimum Berk. & Curt. Grevillea 1: 100. 1873.

Hydnum ischnodes Berk. Grevillea 1: 101. 1873. *non* Morgan.

Hydnum chrysocomum Underw. Bull. Torrey Club. 24: 82. 1897.

Acia chrysocoma (Underw.) Pat. Tax. Hymén. 69. 1900.

Odontia crocea Lloyd, Letter 53: 11. 1914.

Fructification resupinate, membranaceous, separable, often becoming partially detached in drying, fleshy-ceraceous, ochraceous-salmon; margin white at first then yellowish, fibrillose and with long, orange colored, rhizomorphic strands running loosely over the substratum; teeth 1-4 mm. in length, slender, terete, occasionally confluent, subdistant to crowded, terminated by sterile hyphae; hyphae 4-7 μ in diameter, and thick-walled in the strands and loosely interwoven mycelium next to the substratum, 2-4 μ in diameter and thin-walled in the more compact spines and subhymenial region, septate, without clamp connections; basidia 15-25 \times 4-6 μ , with 2-4 sterigmata; spores 3.5-4.5 \times 2-2.5 μ , ellipsoid, smooth, hyaline.

This species is recognized by its bright orange fructification and the long, mycelial strands of the same color. Its growth is restricted to the lower side of much decayed limbs or bits of wood,

particularly those that are partially submerged in the forest floor. The host tissue immediately above the fructification is often colored red.

I have not seen the type of *H. fragilissimum*. However, I have examined a specimen at The New York Botanical Garden which was taken to Europe and compared with the type by Banker, who has indicated on the label that it is "undoubtedly" the same. The original description of *H. fragilissimum* applies closely to this species. Since the orange usually fades in the herbarium the "white" color mentioned by Berkeley is readily explained. No. 4. *Hydnum fragilissimum* Berk. & Curt. in Ellis, North American Fungi, is correctly determined. I have examined the types of *Hydnum ischnodes* Berk. and *Hydnum chrysocomum* Underw. and an authentic specimen of *Odontia crocea* Lloyd. They represent the same species. Lloyd applies Schweinitz's specific name *croceum* to this species merely on the basis of the meager original description. It seems strange that he should come to this conclusion after making an earlier comment (Letter 42: 4) on the same species, "there is nothing in Schweinitz's short 'description' to give any clue even to its identity."

Common in Iowa on decayed wood of frondose species. Collected from June to January. Its occurrence in six or seven central and eastern states is recorded.

4. OXYDONTIA MACRODON (Fries) Miller, Mycologia 25: 294. 1933. (PLATE 43, FIG. 7)

Hydnum macrodon Pers. ex Fries, Syst. Myc. 1: 415. 1821.

Hydnum fragile Pers. ex Fries, Syst. Myc. 1: 418. 1821.

(non Fries. 1874.)

Dryodon mucidum Quél. Fl. Myc. Fr. 438. 1888.

Hydnum separans Peck, Ann. Rep. N. Y. State Mus. 50: 112. 1897.

?*Odontia macrodon* (Fries) Bourd. & Galz. Bull. Soc. Myc. Fr. 30: 264. 1914.

Fructification resupinate, widely effused, soft, subceraceous, farinaceous, membranaceous, separable, often becoming partially detached in drying, light buff when fresh; margin white, similar or byssoid; spines 5-10 mm. or less in length, 0.2-0.3 mm. in

diameter, slender, subulate, terete, sterile at the apices, crowded, often coalescing, scattered near the margin, occasionally curved; hyphae $2-4\ \mu$, distinct, with numerous clamp connections, guttulate; gloeocystidia cylindrical to fusiform, with elongated, subulate and projecting terminations, occasionally obtuse, slightly tortuous, $40-100 \times 5-9\ \mu$; basidia $20-30 \times 4-6\ \mu$, clavate, guttulate, with 2-4 sterigmata; spores $4-6 \times 3-5\ \mu$, subspherical, smooth, hyaline, 1-guttulate.

This species may be recognized by the soft, sub-ceraceous fructification, the long slender spines, the gloeocystidia and the subspherical spores.

Fairly common in Iowa from October to December, on much decayed wood of frondose species. This species may be reported in this country under different names. A number of specimens were observed at The New York Botanical Garden and in other herbaria, which were collected from widely scattered points in the eastern United States and variously determined. The type of *Hydnum separans* Peck seems to possess the characters of a typical specimen of *O. macrodon*. This species has occasionally been referred to *Hydnum nucidum* Pers. The type of the latter species, however, represents an entirely different fungus according to Bresadola (1897), Donk (1931) and Bourdot (1932). *Hydnum fragile* Fries (1874) is applied to a stipitate form.

5. *OXYDONTIA SETOSA* (Pers.) Miller, Mycologia 25: 294. 1933.
(PLATE 43, FIG. 9)

Hydnum setosum Pers. Myc. Europ. 2: 213. 1825.

Hydnum luteocarneum Secr. Mycogr. Suisse 2: 528. 1833.

Hydnum Schiedermayeri Heuf. Oest. Bot. Zeitschr. 20: 33. 1870.

Dryodon setosum (Pers.) Pat. Hymén. Europ. 146. 1887.

Dryodon luteocarneum (Secr.) Quéf. Fl. Myc. Fr. 437. 1888.

Hydnum earleanum Sumst. Torrey 4: 59. 1904.

Hericium croceum (Schw.) Banker, Mem. Torrey Club 12: 121. 1906.

Manina Schiedermayeri (Heufl.) Banker, Mycologia 4: 277. 1912.

Hydnum foetidum Vel. České Houby 744. (fide Cejp). 1922.

Acia setosa (Pers.) Bourd. & Galz. Hymén. Fr. 418. 1928.

Fructification resupinate, becoming widely effused, ceraceous, adnate, thick, sometimes with tuberculous nodules from which curved teeth arise, giving off a strong odor resembling bitter almonds when fresh, primuline yellow, becoming dark with age; margin radially and coarsely fibrillose; spines 4–10 mm. in length, slender, terete, subulate, often swollen and somewhat pubescent at the base, fascicled on the nodules or arising singly, colored similarly to the context or with reddish tips; hyphae 2–5 μ in diameter, thin-walled, with occasional clamp connections, compactly arranged, horizontal next to the substratum; basidia 15–25 \times 4–6 μ , with 4 sterigmata; spores 5–6 \times 3–4.5 μ , obovate, smooth, hyaline, uni-guttulate.

The bright yellow color, the strong pungent odor, the nodulose subiculum, the small obovate, 1-guttulate spores and the largely restricted habitat on pomaceous wood clearly marks this species from other hydnums.

This species is known in Europe as *Acia setosa*. In the United States it commonly goes under the name *Hydnum Schiedermayeri*. I retain the older specific name with some uncertainty since Persoon first described the fructification as "white."

Common on the dead trunks and limbs of *Malus* and *Crataegus* from May to December. Its occurrence is widely reported throughout the central and eastern United States.

6. OXYDONTIA STENODON (Pers.) Miller, Mycologia 25: 294. 1933. (PLATE 43, FIG. 10)

Hydnum stenodon Pers. Myc. Europ. 2: 188. 1825.

Odontia stenodon (Pers.) Bres. Atti Accad. Rovereto III. 3: 96. 1897.

Acia stenodon (Pers.) Bourd. & Galz. Bull. Soc. Myc. Fr. 30: 256. 1914.

Hydnum mucidum Vel. České Houby 744. (fide Cejp.) 1922.

Fructification resupinate, effused, fleshy-ceraceous, adherent, mars yellow in younger portions to mars brown in older; margin lighter in color; spines 1–2 mm. or less in length, slender, tapering, mostly entire, sometimes fimbriate, crowded and more or less coalescing at the base, sterile at the apex, mars brown; hyphae 2–3 μ in diameter, thin-walled, somewhat coalesced; basidia 10–15 \times 3–4 μ , clavate; spores 3–4.5 \times 1.5–2.5 μ , elliptical, depressed on one side, smooth, hyaline.

The Iowa specimen resembles *Odontia uda* and *O. fuscoatra* but has smaller spores than either, does not possess the incrustated axial and often emergent hyphae of the spines and may be distinguished by the reddish and more fleshy subiculum. It does not turn purple in a potassium hydroxide solution.

Collected once in Iowa on basswood, Aug. 8, 1931. Reported from New Jersey by Cejp (1931) but the specimen is *Oxydontia fragilissima* (Berk. & Curt.) Miller as treated in this paper. Several specimens of *Odontia stenodon* (Pers.) Bres. from Bresadola at The New York Botanical Garden, two specimens of *Acia stenodon* (Pers.) Bourd. & Galz. from Bourdot at the Lloyd herbarium and a specimen of *Acia stenodon* (Pers.) Bourd. & Galz. from Litschauer have been seen. Several of these specimens cast doubt upon my determination. The specimen from Litschauer and one from Bresadola differ in having the spines more coalesced and more or less fimbriate, and spores which are distinctly curved.

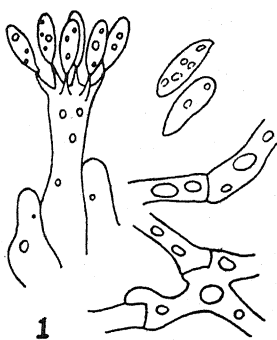
The writer is indebted to Professor G. W. Martin for his advice and suggestions during the preparation of this paper.

DEPARTMENT OF BOTANY,
STATE UNIVERSITY OF IOWA,
IOWA CITY, IOWA

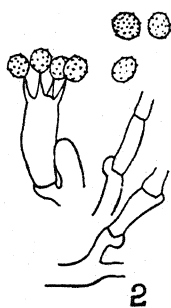
EXPLANATION OF PLATE 43

All figures drawn with camera lucida at a magnification of 1650 diameters, reduced to $\times 1000$ in reproduction. Hyphae, basidia and spores are shown in each figure except figure 4 which includes only a characteristic antler-shaped structure and spores and figure 7 in which a gloeocystidium is added.

Figs. 1-6, *Grandinia*: 1, *G. raduloides*; 2, *G. farinacea*; 3, *G. Brinkmanni*; 4, *G. granulosa*; 5, *G. mutabilis*; 6, *G. helvetica*. Figs. 7-12, *Oxydontia*: 7, *O. macrodon*; 8, *O. fragilissima*; 9, *O. setosa*; 10, *O. stenodon*; 11, *O. Himantia*; 12, *O. albobiride*.



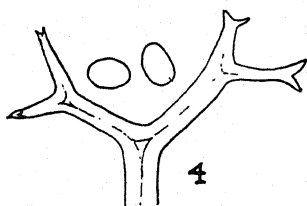
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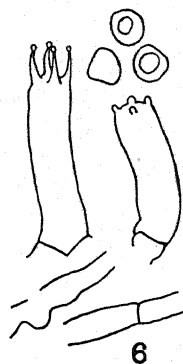
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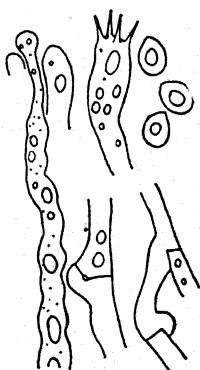
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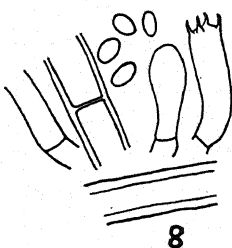
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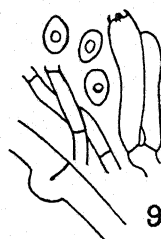
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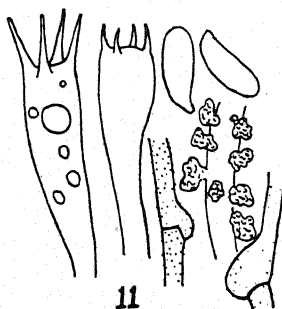
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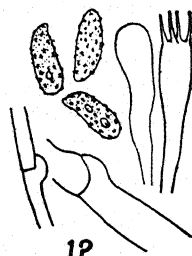
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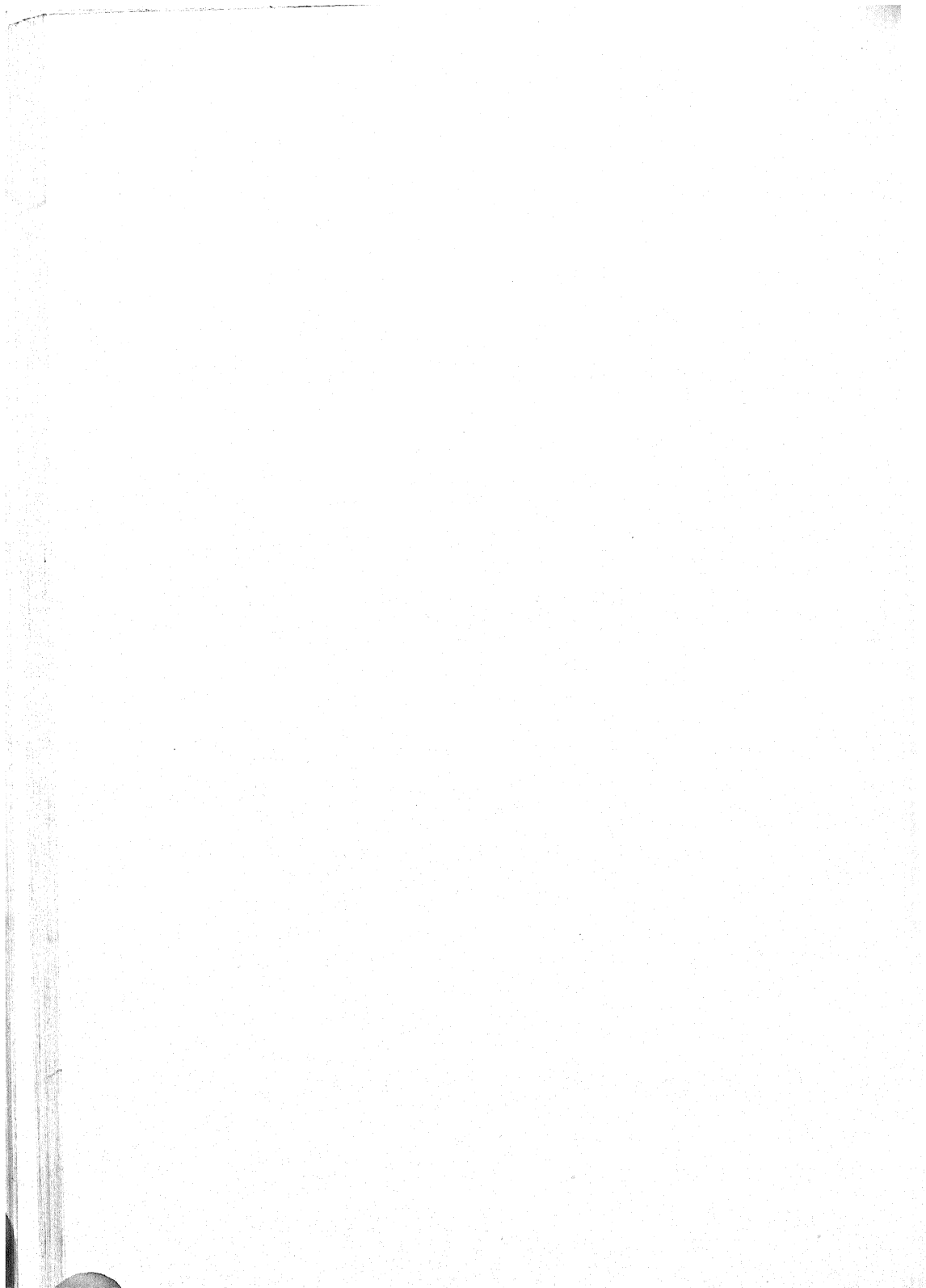
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AN UNDESCRIBED PHOMOPSIS FROM DOUGLAS FIR ON THE PACIFIC COAST

GLENN GARDNER HAHN

(WITH PLATE 44)

INTRODUCTION

During the spring of 1930 striking cankers on the green form of Douglas fir, *Pseudotsuga taxifolia* (LaM.) Brit., were collected by Prof. R. E. Smith, University of California and Mr. W. W. Wagener, at Lokoya, Napa County, California. A preliminary examination of the fungus which was found fruiting abundantly associated with the cankers, showed an organism closely related to *Phomopsis Pseudotsugae* Wilson (5), which previous investigation had shown to be the cause of canker and die-back of Douglas fir and other conifers in the British Isles and on the Continent (6, 7). Inasmuch as the cankers from Douglas fir on the Pacific Coast were practically identical with those caused by the *Phomopsis* on the same host in Britain (5, figs. 14, 15, 17), it was economically important to determine whether these two organisms were morphologically and culturally identical.

It does not lie within the scope of this paper to discuss in detail the pathological phases of this problem. These will be found in a separate publication in which the symptoms and nature of the disease are discussed by Dr. J. S. Boyce,¹ who undertook a field study of the canker to determine its distribution. The present paper deals mainly with the mycological characters of the Californian fungus which is herein described below as a new species.

RELATIONSHIP OF THE NEW PHOMOPSIS TO OTHER PHOMOPSES OF CONIFERS

For the purpose of determining whether or not the *Phomopsis*, whose presence was made conspicuous as the result of a canker

¹ The discussion of the Douglas fir canker disease by Dr. J. S. Boyce will appear in the *Journal of Forestry* 31: 1933 under the title, "A Canker of Douglas fir Associated with *Phomopsis Lokoyae*."

epidemic among young Douglas fir in 1930, was an undescribed species, careful morphological and cultural comparisons were made with four related species occurring on conifers—*P. juniperovora* Hahn, *P. occulta* Trav., *P. Pseudotsugae* and *P. Strobi* Sydow. These coniferous species were chosen for the reason that the measurements of the alpha or A-type spores (elliptic-fusoid or oblong-elliptical) belonging to this group did not differ greatly either in length or width.

Although the morphological characters of the fruiting body and the A-type spores of *P. occulta* and the new fungus were quite similar, the former produced a pronouncedly scolecosporic, beta or B-type spore (2) which was quite distinct from the shorter elongate type found in the latter. *P. occulta* which occurs commonly on a large number of coniferous genera including Douglas fir, both in this country and in Europe, has been proved culturally to be the imperfect stage of *Diaporthe conorum* (Desm.) Niessl. The perfect stage of the undescribed species, on the other hand, is at present unknown. This is also true in the case of the parasite, *P. juniperovora*, which causes blight and canker among cedar nursery stock in the Middle West and along the Atlantic seaboard. The filamentous B-type spores produced by the cedar parasite (2) unknown to occur naturally on Douglas fir, differed in shape and size and the A-type spores were slightly larger. The culture characteristics of the three species being compared were quite distinct.

It was found that the pycnidia formed by the new species from the Pacific Coast were typical for the genus *Phomopsis* (1) in that the spore-bearing cavity at inception was generally found to consist of a single chamber or locule which became somewhat irregular with pseudo-partitions or outgrowths from the side or lower walls of the fruit body. In this it differed from *P. Pseudotsugae* and *P. Strobi*, for as has been pointed out in a previous paper (2) the pycnidia of these are atypical in that they tend to become irregularly unilocular after fusion takes place among a number of previously-formed sporebearing cavities. Neither *P. Pseudotsugae* nor *P. Strobi* are known to produce B-type spores. Culturally the new *Phomopsis* differed from these two species.

It is of interest here to call attention to the fact that the cultural characteristics of *P. Strobi* have been found to be practically

identical with those of *P. Pseudotsugae*. In consequence the former species, which the author in earlier studies (2) intimated was very closely related morphologically to the latter, may very probably be considered a form of the earlier species recognized as a parasite on exotic Douglas fir in Europe. Further studies are now being undertaken with the purpose of demonstrating the perfect stage.

Measurements of spores from four collections of the undescribed *Phomopsis* (50 A-spores each) from different sources in California showed closely corresponding spore-size ranges. The frequency distributions of A- and B-spores are presented in Table 1.

TABLE 1
DIMENSIONS OF THE PYCNIDIOSPORES OF PHOMOPSIS LOKOYAE
ARRANGED IN CLASSES

A-spores				B-spores			
Length		Diameter		Length		Diameter	
Class μ	No. of spores in 200	Class μ	No. of spores in 200	Class μ	No. of spores in 100	Class μ	No. of spores in 100
4-4.9	1	1-1.9	1	9-9.9	9	1-1.9	26
5-5.9	7	2-2.9	76	10-10.9	31	2-2.9	72
6-6.9	39	3-3.9	119	11-11.9	38	3-3.9	2
7-7.9	73	4-4.9	4	12-12.9	12		
8-8.9	53			13-13.9	7		
9-9.9	23			14-14.9	3		
10-10.9	4						

The fungus was identified from cankers collected by Boyce on Douglas fir in Josephine County, Oregon, along the Pacific Highway just over the California state border. The dimensions of both A- and B-spores closely corresponded with the size range determined for the organism growing in California. The A-spores produced artificially on sterilized stems of Douglas fir (*Pseudotsuga taxifolia*, Colorado blue form) at ordinary room temperature were practically identical in size with those produced in nature.

In searching for an earlier collection of the organism in California, possibly identified under another name, the type specimen of *Phoma Pini* Cooke & Hark. (No. 1548, Harkness Herbarium, Grevillea 9: 81. 1881) collected on fir (dead bark) at Healds-

burg, Sonoma County, Calif., April 29, 1880 and deposited in the Herbarium of the California Academy of Science, San Francisco, was examined upon the suggestion of Dr. W. W. Diehl. Slides of the type prepared and deposited in the California Herbarium by Diehl showed the pycnidium of a fungus whose structure did not suggest a *Phomopsis*. A species of *Diplodia* also was found in the type specimen occurring abundantly. Another interesting specimen in the Herbarium, Mycological Collections, Washington, D. C., collected by the late Ellsworth Bethel in 1923 on *Pseudotsuga taxifolia*, Pikes Peak, Colorado, and determined by Diehl as *Phoma Douglasii* Oud. [*Sclerophoma Douglasii* (Oud.)] with elliptical spores, $8-9 \times 3-3.5 \mu$, is neither a *Phoma* nor a *Phomopsis*, but appears to be as identified, a species of *Sclerophoma*.

In view of the distinguishing morphological and cultural characters of the Pacific Coast *Phomopsis* which differentiate the organism from every other coniferous *Phomopsis* studied, it is described accordingly as a new species:

***Phomopsis Lokoyae* sp. nov.** Pycnidia closely aggregate, ectostromatic, embedded, arising among the cells of the periderm where the fruit body is more or less incorporated with the host tissue and becoming erumpent, fuscous-black; carbonaceous; cone-shaped, lenticular or subglobose, truncate (PLATE 44, FIGS. 1, 2); approximately two times as broad as high, mostly 300 to 565 μ in diameter and 175 to 300 μ in height; pycnidiospores emerging in a whitish tendril or globular gelatinous mass from a single locule or chamber lined with a hymenial layer of slender, flexuous, subulate, sub-acutely pointed sporophores 5–20 μ long (PLATE 44, FIG. 3), from the tips of which the spores are abstricted; cavity unilocular with protrusions from the side and basal walls forming pseudo-partitions, and with a thickened pseudo-parenchymatous layer above; occasionally with more than one locule. A-spores (PLATE 44, FIG. 4), unicellular, hyaline, variable in shape, elliptic-fusoid, oblong-elliptic, or oblong with obtuse or subacute extremities, commonly bi-guttulate, mostly 6–10 μ in length and 2–4 μ in diameter, extreme range, 200 spores, 4 collections, $4.8-10.0 \times 1.6-4.0 \mu$; B-spores (PLATE 44, FIG. 5), hyaline, unicellular, somewhat scolecosporic, elongate, bilateral with obtuse or subacute extremities, minutely guttulate, mostly 10–12 μ in length and 1.5–2.5 μ in diameter, extreme range, 100 spores, 2 collections, $9.0-14.2 \times 1.4-3.2 \mu$.

Pycnidiis discretis vel aggregatis; ab initio subepidermicis denique erumpentibus, carbonaceis, lenticularibus, conoideis, truncatis, vel subglobosis;

basibus complanatis, ostioli paulo pertusis, vel deficientibus; contextu heterogeneo praeditis, matricibus fuliginis supra cavitates sporiferas incrassatulis; unilocularibus $175\text{--}300\ \mu$ alt., $300\text{--}565\ \mu$ diam. A-sporulis, hyalinis, continuis, ellipticis-fusoidis, oblongis-ellipticis vel oblongis, guttulis (200), $4.8\text{--}10.0 \times 1.6\text{--}4.0\ \mu$, vulgo $6\text{--}10 \times 2\text{--}4\ \mu$. Scolecosporulis, subfiliformibus, hyalinis, continuis, guttulis, (100) $9.0\text{--}14.2 \times 1.4\text{--}3.2\ \mu$, vulgo, $10\text{--}12 \times 1.5\text{--}2.5\ \mu$. Basidiis, continuis, subulatis, tenuibus, brevibus, $5\text{--}20\ \mu$.

Hab. In ramis et truncis vivis et emortuis *Pseudotsugae taxifoliae* (LaM.) Brit. in America boreali (California, Oregon) 1930.

The perfect stage is unknown. Perithecia were not produced in experiments in which mono-pycnidiospore strains were crossed in 3 per cent malt and ground oatmeal agar cultures. The single spore strains were isolated from cankers obtained from widely separated localities in California and Oregon.

Hab. The fungus has been observed on living and dead cankered Douglas fir (*Pseudotsuga taxifolia*), green form, in California and Oregon in 1930. The following collections of the organism were made in California in 1930: Napa County—F. P. 53025,² R. E. Smith; F. P. 53026–7–8, W. W. Wagener; F. P. 53032–6, E. P. Meinecke, W. W. Wagener, and E. Wright; F. P. 53068, J. S. Boyce; Trinity County—F. P. 53030–1, E. P. Meinecke, W. W. Wagener and E. Wright; Mendocino County—F. P. 53711, J. S. Boyce. A collection, F. P. 53061, J. S. Boyce, was made the same year in Josephine County, Oregon.

A specimen and slide of the fungus (Type, F. P. 53025, collected R. E. Smith, Lokoya,³ Calif.) have been deposited in the Herbarium, Mycological Collections, Washington, D. C.

CULTURE NOTES

Strains of *Phomopsis Lokoyae* isolated from single spores and from inner bark tissue of cankers collected from different localities in California showed fair agreement as regards their cultural characters. The organism grew readily upon corn meal plus 2 per cent cane sugar, ground oat and 3 per cent malt agars. Upon the malt agar it produced at room temperature an olivaceous color in the midstratum somewhat hidden by a low-growing yet abundant whitish aerial hyphal growth. With age this olivaceous color darkened considerably and the whitish, aerial growth took on a thin and

² Number refers to collection in the Division of Forest Pathology.

³ A summer resort among the Napa County hills.

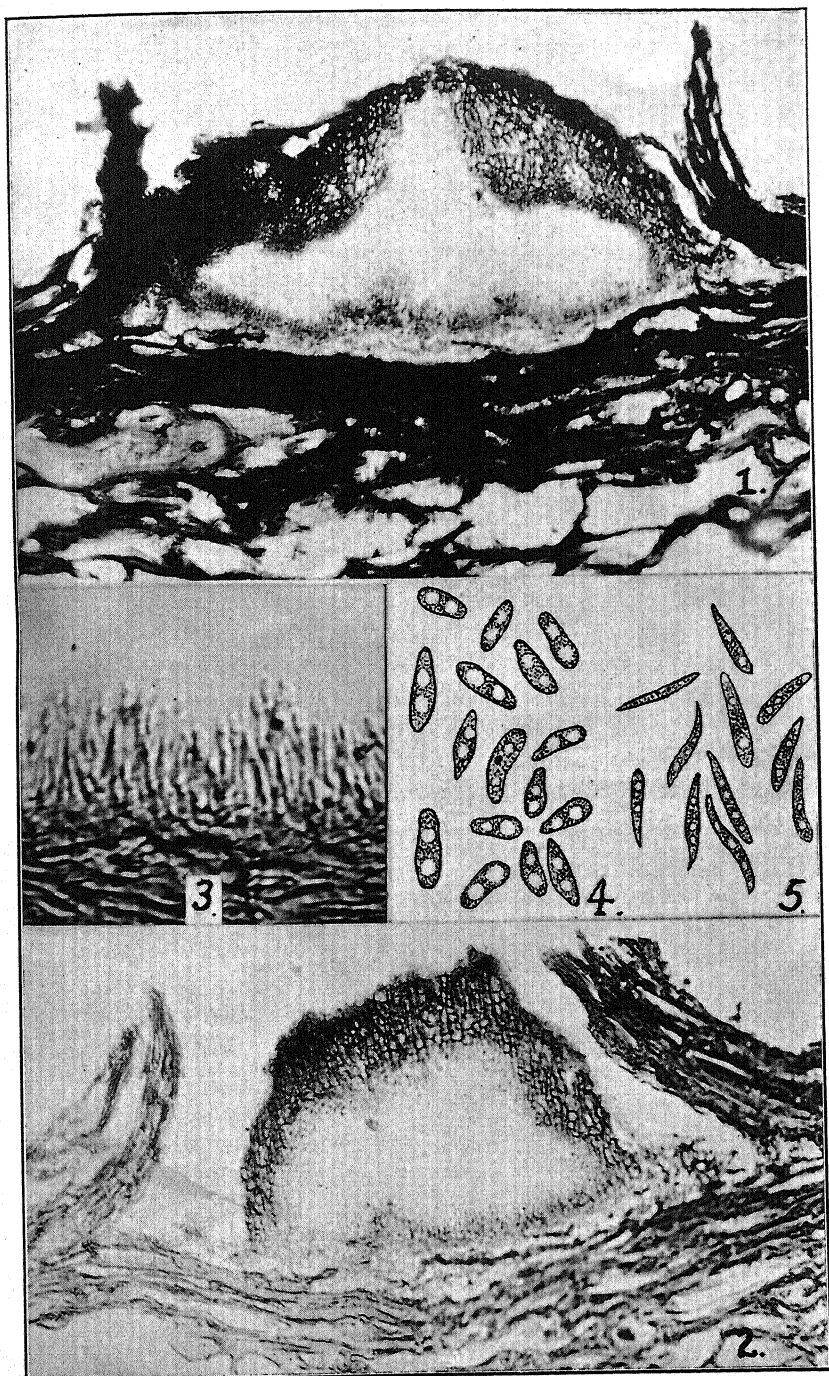
patchy appearance. Within three weeks whitish crystals had formed in the medium, which were observed to appear repeatedly upon further culturing.

These crystals were not observed to form in cultures of *Phomopsis Pseudotsugae* or *P. occulta*. As previously reported crystals formed in cultures have likewise aided in distinguishing other coniferous *Phomopses*, e.g., the flaming red crystals produced in cultures of *P. juniperovora* served as a differentiating character in separating the cedar parasite from the non-crystal-forming innocuous saprophyte, *P. occulta*.

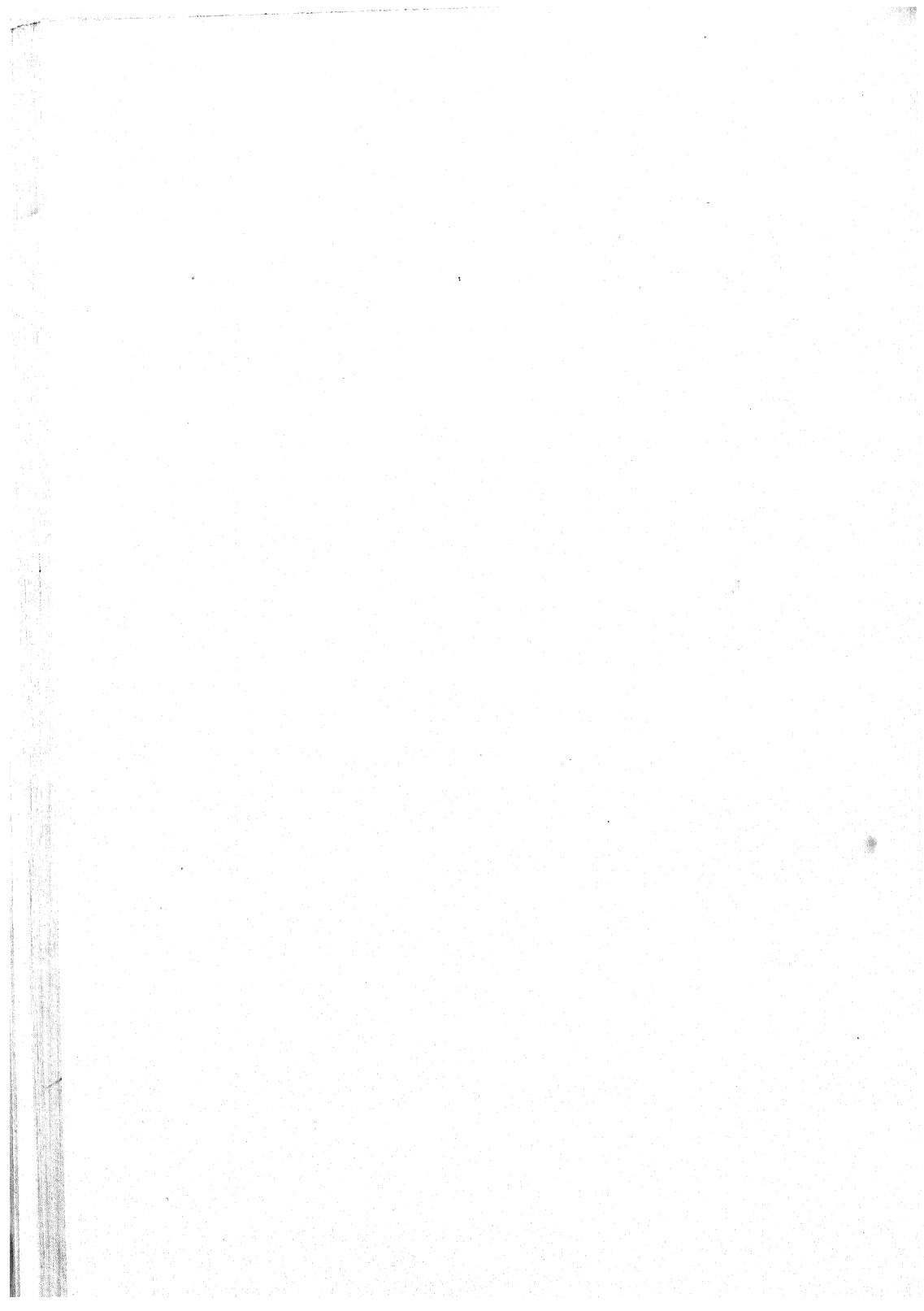
Unlike the other *Phomopses* species mentioned in this paper which sporulate abundantly under artificial conditions, *P. Lokoyae* did not fruit readily in culture. Upon both malt and oat agars it produced dark stromatic primordia but these were mostly sterile, forming spore-bearing cavities very reluctantly. The fungus was induced to fruit by growing it on sterilized Douglas fir twigs.

DISCUSSION

Phomopsis Lokoyae appears to be a distinct species among the coniferous *Phomopses* which the author has studied. It has never been observed in the East on planted Douglas fir nor has the organism been collected on the blue form of the host species in the Rocky Mountain region. On the Pacific slope it occurs only on the green form of Douglas fir within a limited range. As in the case of *P. abietina* (Hart.) Wilson & Hahn (*Phoma abietina* Hart.) a parasite of continental Europe, which forms cankers only on small branches of silver fir (*Abies pectinata* D. C.), *P. Lokoyae* likewise appears limited to a given host species. Boyce found the canker disease associated with *P. Lokoyae* to be locally epidemic during the dormant season of 1929-30 because of a combination of heavy rainfall in June, 1929 followed by a protracted drought. He regards the organism as native and one which has become evident as a result of the canker epidemic with which it has been found associated. The silver fir branch canker parasite in Europe has also been reported epidemic in certain years (3, 4). It is not regarded by conservative pathologists there as serious but rather as one which does not become pathogenic until there arises a combination of conditions which favor its parasitic attack. This same statement very probably holds true for *P. Lokoyae*.



PHOMOPSIS



SUMMARY

A hitherto unrecognized species of *Phomopsis* on the Pacific Coast associated with a definite canker of young Douglas fir, *Pseudotsuga taxifolia*, is herein described as *P. Lokoyae* sp. nov. This organism is morphologically and culturally distinct from *P. Pseudotsugae* which previous investigation has shown to cause a similar canker of exotic Douglas fir in Europe. The western *Phomopsis* appears to be confined to a single host species and to a limited geographical range.

DIVISION OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
IN COOPERATION WITH THE
OSBORN BOTANICAL LABORATORY,
YALE UNIVERSITY

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EXPLANATION OF PLATE 44

Fig. 1, Pycnidium, *Phomopsis Lokoyae*, showing ostiole, $\times 360$; 2, Pycnidium, *P. Lokoyae*, with well-developed pseudoparenchymatous tissue above sporebearing cavity, $\times 360$; 3, Sporophores, $\times 1000$; 4, A-spores, $\times 1100$; 5, B-spores, $\times 1100$.

NEW OR NOTEWORTHY AGARICS FROM OREGON¹

S. M. ZELLER

In this paper eight species are described as new and three new combinations are proposed. Sixteen species are listed as new to Oregon, and ten new to America are as follows: *Galerula pygmaeoaffinis* (Fries) Zeller, *Hypholoma dispersum* Fries, *Lactarius obnubilus* (Lasch) Fries, *Lepiota rhacodes* (Vitt.) Fries, *Naucoria escharoides* Fries, *Pleurotus limpidus* Fries, *Psalliota angusta* Fries, *P. dulcidula* Schulz., *Stropharia psathyroides* Lange, and *Tricholoma amplum* (Pers.) Rea. Types of the new species are in the Oregon State College Herbarium. Ridgway (10) was used as a color standard in the descriptions of new species.

1. AMANITA MUSCARIA Fries.

In sandy pine barrens along the ocean coast, in sandy loam along rivers or under poplars in various types of soil. Frequent. Always gregarious and in quantity. Usually from October to December but infrequently in the spring.

Kauffman (3) has given an interesting note concerning the distribution of different color forms of this species in America. At that time Kauffman was not familiar with *A. muscaria* on the Pacific coast, but several times since we have mentioned how our coastal form conforms in color to the dark red European form. More recently Kauffman (5) reported the scarlet form from Mt. Hood, Oregon. In the pine barrens along the coast the scarlet red form predominates but in the interior valleys and hill-lands of Oregon and Washington the well-known orange-yellow to pale yellow form, or the scarlet form may be found. Large fields of either form are often found. I am inclined with Professor J. E. Lange of Denmark, to the belief that the form which occurs com-

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monly in eastern states is a distinct species. As stated above, both occur in Oregon.

2. *Armillaria granuloides* sp. nov.

Gregaria: pileo 2-5 cm. lato, convexo, dein expanso vel plano-depresso, squamuloso vel erecto-squarroso, levi ochraceo demum cremeo et saepe rufo-tincto; carne tenui alba; lamellis latis confertis adnatis vel subdecurrentis saepe e stipite secedentibus albis vel cremeis, acie levis; stipite 2-5 cm. longo, 2-4 mm. crasso, utrimque rufescente vel fulvescente annulum peronato, squamis floccosis cremeis vel fulvis; anulo superiore tenui evanido; sporis curti-ellipsoideis hyalinis levibus $3-4.5 \times 2-3 \mu$, saepe duonis vel quaternis.

Hab. ad terram muscosum ad margini silvarum coniferarum (*Pseudotsuga taxifolia*) prope Wren. Oregon Amer. bor. (S. M. Zeller and E. M. Harvey).

Pileus 2-5 cm. broad, convex, expanding to plane and usually depressed in center; *surface* squamulose scaly to erect squarrose, scales light ochraceous-buff to tawny, sometimes staining almost russet (drying light buff, pale ochraceous-buff to light ochraceous-buff), creamy or buffy between the scales; *flesh* thin, white to creamy; *gills* broad, close (not crowded), inserted, adnate to slightly decurrent, often breaking away, white to creamy (drying light buff), edges even; *stem* 2-5 cm. long, 2-4 mm. diam., rufescent to tawny above and below, peronate with floccose to subfloccose scales to a slight fugacious floccose ring, scales creamy to tawny; *spores* short ellipsoidal, hyaline, $3-4.5 \times 2-3 \mu$, often adhering in groups of 2, 3 and 4.

Gregarious; in mossy places at the margin of young Douglas fir growth, on the divide between Wren and Kings Valley, Benton County. Elevation 1300 ft. November. Collected by S. M. Zeller and E. M. Harvey.

In general appearance this plant is close to *Armillaria* (*Lepiota*) *granulosa* Fries from which it differs in several details. The trama of the stipe and pileus are continuous and the gills are adnate to almost decurrent. Kauffman has transferred the closely related species of *Lepiota* to *Armillaria*. For those who prefer the former disposal of these species this plant should bear the name, *Lepiota granuloides*.

3. *ARMILLARIA ROBUSTA* Fries.

In sand under pines, Lane to Lincoln Counties, November. Frequent along the coast.

So far as the writer is aware this is the first report of this species

from the west. It is a large species reaching 18 cm. across and 15 cm. high. It agrees in every other particular with descriptions by European mycologists.

4. *Armillaria rugoso-reticulata* (Lorin) Zeller, comb. nov. (Syn. *Lepiota rugoso-reticulata* Larin).

In mixed woods, several locations in Benton County, November and December. Frequent in rather dense virgin forests.

Kauffman has reported this species from Michigan and the Siskiyou Mountains, Oregon (6). In the Oregon material the spores are $4-6 \times 3-3.5$. It is otherwise as described. The pileus is antimony-yellow to ochraceous-buff on the margin to buckthorn brown (10) on the disk when fresh, drying buckthorn brown to Dresden brown. The gills are adnate and the stipe is continuous with the trama of the pileus.

5. *Bolbitius marginatipes* sp. nov.

Gregaria vel subcaespitosa: pileo 1-4 cm. lato campanulato dein expanso membranaceo, levi vel innato-fibrilloso tenuiter glutinoso, tenuiter radiatim rugoso plicato-striato vel margine sulcato, centro glabro isabellino margine griseo vel griseo-albo; stipite fragili aequali cavo striatulo albo ad basem bulboso nigrofimbriato-marginato, 2-8 cm. longo, 2-3 mm. crasso; lamellis stipite adnatis tenuis, 1-1.5 mm. crassis, scissilis griseolis dein brunneis, acie levibus; carne tenui alba; sporis ellipsoideis vel citriformis levibus, $12-14 \times 7.5-9 \mu$, obscuro-ochraceis apice truncatis; cystidiis nullis visis.

Ad terram finatam in viridariis Corvallis, Oregon Amer. bor. (F. D. Bailey, B. F. Dana, et S. M. Zeller).

Pileus membranous, conical, then expanded to almost plane, 1-4 cm. broad; *surface* smooth to innate fibrillose, somewhat viscid, somewhat radially rugose, plicate-striate to splitting $\frac{1}{2}$ way up from margin in expanded plants, isabella color on disk and grayer toward margin in young plants to grayish white when mature; *stem* brittle, cylindrical from a marginate, bulbous base, margin distinct but blackish fimbriate above which stem is white, finely longitudinally striate, hollow, 2-8 cm. by 2-3 mm.; *gills* grayish, then ochraceous to antique brown (10) adnate, narrow (mostly about 1-1.5 mm.) with some very narrow (about $\frac{1}{4}$ mm.) splitting, thin, margins even; *flesh* white, membranous; *spores* dark ochraceous, broadly ellipsoid to citriform, with a hyaline apical germ-pore, $12-14 \times 7.5-9 \mu$, smooth. *Cystidia* not seen.

On fertile manured soil in greenhouse; gregarious. January. Collected by F. D. Bailey, B. F. Dana and S. M. Zeller.

This material is very close to *B. titubans* (Bull.) Fries but dif-

ers in the color of the pileus and stem and in the striations on the stem and the marginate bulbous base, which suggests the name. The splitting takes place into the trama of the narrowest gills which open above, hinge-like on their edges as in several species of *Coprinus*. The young stages appear like *Coprinus*.

6. *CANTHERELLUS CLAVATUS* Fries.

Under conifers near Newport, Oregon. October.

Previously reported from the Olympic Mountains and Mt. Hood but in contrast this collection at the coast is of interest because of the range in altitude.

7. *CLITOCYBE DEALBATA* (Sow.) Fries.

In pastures and lawns. Very common. September to December. Although this species is so commonly found no definite report of it from Oregon has been recorded.

8. *COPRINUS OVATUS* Fries.

Five specimens were sent from Portland, Multnomah County, for identification.

This is the only collection so far reported from Oregon but undoubtedly should be referred here if this is a good species. The spores in this collection are $9-13.4 \times 6-8.8 \mu$, the caps are ovoid and the whole plant reaches a maximum of 11 cm. Under our climatic conditions it is not unusual to find *C. comatus* reaching a height of 25-38 cm. Ricken (9) gives *C. ovatus* as a distinct species while Rea (8) considers it a variety of *C. comatus*.

9. *FLAMMULA ALNICOLA* Fries.

On the ground at the base of alders and on decayed alder stumps. Swim, Clackamas County. Collected and determined by J. E. Lange and the writer. Frequent. First report of this species west of Colorado (3).

10. *FLAMMULA FLAVIDA* Fries.

On coniferous wood along an old corduroy logging road, near Hemlock, Tillamook County. September. Frequent. Collected and determined by Jakob E. Lange and S. M. Zeller.

Longyear once found this species in Michigan, but this seems to be the first report from any western state unless *Gymnopilus flavidellus* Murrill may be the same.

11. *GALERULA ANTIPUS* (Lasch) Atkinson.

On horse dung, Rhododendron. September. Frequent. Collected by Jakob E. Lange and S. M. Zeller.

Spores are $8-10 \times 6-7 \mu$, angularly 6-sided to limoniform. Previously reported from North Carolina.

12. *Galerula martipes* (Kauffm.) Zeller, comb. nov. (Syn. *Galera martipes* Kauffm. (5)).

Under conifers, Rhododendron. September.

13. *Galerula pygmaeoaffinis* (Fries) Zeller, comb. nov. (Syn. *Galera pygmaeoaffinis* Fries).

Under oak among scant grass. Northwest of Corvallis. December.

The material is hardly referable to any other described species. The pileus is distinctly sulcate and reticulately wrinkled. The spores in ours are $14-18.4 \times 8-11.3 \mu$, with a prominent germ pore.

14. *GOMPHIDIUS NIGRICANS* Peck.

In mixed woods, Rhododendron; in coniferous woods near Newport. September–October. Infrequent.

Professor Jakob E. Lange and the writer first collected and identified the specimens from Rhododendron, and a few days later Mr. G. R. Hoerner brought in material from near the ocean beach (Newport). So far as we can find, this is the first report of this species from Pacific Coast States.

15. *HYGROPHORUS PUNICEUS* Fries.

In mossy woods, Coos County. February.

The Oregon plant seems in every way like that described in Europe but I find no record of the extremely foetid odor of the decaying plants. Growing, sound plants have a mild taste and odor.

16. *HYPHOLOMA DISPERSUM* Fries.

Under *Picea sitchensis*, near Beaver, Tillamook County, September.

This evidently is the first report of this species from America. Collected by Dr. Jakob E. Lange and the writer. Dr. Lange had no doubt of its identity.

17. *LACTARIUS OBNUBILUS* (Lasch) Fries.

Under alder trees or on alder wood, Rhododendron. September. Not uncommon. Collected by J. E. Lange and the writer.

18. *LEPIOTA ERIOPHORA* Peck.

Under conifers, Benton and Linn Counties. October. Infrequent.

The spores in ours are $3.5-4 \times 2-2.5 \mu$, and they adhere in 2's and 4's.

19. *LEPIOTA FLAMMEATINCTA* Kauffm.

In mixed woods, Alsea Mountain, Benton County. December.

One specimen was found which closely fits Kauffman's (4) description but the spores are broadly ellipsoid and measure $5-6 (7) \times 3.5 (4)$, while Kauffman gives $8-9 \times 4-4.5$.

The pileus, stem above and below the annulus and the flesh change to red when touched or bruised. The gills remain white when bruised. It is close to *L. roseifolia* Murrill.

20. *Lepiota Kauffmanii* sp. nov.

Gregaria: Pileo 2-5 cm. lato, campanulato dein expanso et umbonato: superficie arida "mars brown" (10), cute glabra demum concentricatim ramosa et carnem subalbam intersquamulam ostendente, disco glabro, margine integro non striato; lamellis liberis subcrassis ventricosus acie levis vel leniter granulosus; stipite gracili 5-8 cm. longo, 2-4 cm. crasso, deorsum angustato vel aequali, glabro, cremeo-albo vel sordido; annulo superiore albo delicatulo-membranaceo subpersistente mobili; sporis cuneiformis ad minor apicis rotundatis, levibus, hyalinis $4-5.5 (6) \times 2.5-3 \mu$; basidiis clavatis $15-20 \times 6-7 \mu$; cystidiis solum in acie lamellarum, saccatis-sphaeroideis vel abrupte clavatis hyalinis $17-21 \times 10-14 \mu$; contextu cremeo, centro crasso margine tenui, sapore farinaceo vel parum ingrato, odore grato.

Ad terram in silvis, prope Alsea Mons, Oregon, Amer. bor. (Mr. and Mrs. S. M. Zeller).

Pileus 2-5 cm. broad, dry, at first campanulate expanding nearly plane umbonate, cuticle at first "Mars brown" breaking into concentrically arranged, small, fibrillose scales to the margin, with almost white flesh between, disk remaining even glabrous, Mars brown, margin not striate; *flesh* creamy, thin, thickened at the umbo; *gills* free, rather broad, ventricose, rounded behind, edges even to slightly granular; *stem* slender, 5-8 cm. long, 2-4 cm. thick, equal to slightly larger above, smooth, creamy white to sordid; *annulus* delicately membranous, superior, white, moveable; *spores* broadly truncate-cuneiform, rounded at smaller end, smooth hyaline, $4-5.5 (6) \times 2.5-3 \mu$; *basidia* clavate, $15-20 \times 6-7 \mu$; *cystidia* only on edge of gills, saccate-sphaeroid to broadly pyriform, hyaline, $17-21 \times 10-14 \mu$; *odor* pleasantly fungoid, *taste* farinaceous to slightly disagreeable.

Gregarious in mixed woods and under thickets of broad-leaved bushes, Alsea Mountain. October. Collected by Mr. and Mrs. S. M. Zeller.

This species is closely related to *L. cuneatospora* Kauffm. and *L. fulvella* Rea. It has much smaller spores than either, and differs from the former in the distinct sterile cells on the edge of the gills, the color of the pileus and size of the basidia. It has no cystidia but the sterile cells on the edge of the gills are similar to the cystidia described by Rea for *L. fulvella*. The spores have a tendency to adhere in groups of 2's and 4's.

I take pleasure in dedicating this species to our late friend, Dr. C. H. Kauffman.

21. *Lepiota pulverapella* sp. nov.

Solitaria: pileo carnoso, 7-12 cm. crasso convexo vel plano-depresso; superficie arida "pecan brown" vel "Rood's brown" (10), mutans cacaotica brunnea, pulverulenta enatus squamis minutis erectis obseto; margine sterile ad maturitatem radiatim rimoso; contextu albo mutans sublutescens, tenui spongioso, centro 8-12 mm. crasso, sapore miti, odore farinaceo; lamellis liberis prope stipite albis sed arescendo carneis vel roseo- et vinaceo-tinctis 6-8 mm. crassis, acie levis vel leniter serrata; stipite 7-10 cm. longo, 1-1.5 cm. crasso sursam attenuato, utrimque glabro, albo tactu brunnescento, cavitare fibrillis sericeis leniter farcta; annulo membranaceo reflexo inferiore albo tactu brunnescento; sporis levis hyalinis ellipsoideo-ovatis, $6-7 \times 4 \mu$.

Ad terram in pratis, prope Peoria, Oregon, Amer. Bor. (*S. M. Zeller*).

Pileus fleshy 7-12 cm. broad, convex to plane or depressed at umbo; *surface* dry, soft, pecan brown to Rood's brown, chocolate brown where bruised, about the same shade of color all over cap, general pulverulent appearance because of the upturned tips of tiny, squamulose scales, splitting somewhat toward the margin in mature specimens; *margin* sterile; *flesh* white changing slightly yellowish when bruised, 8-12 mm. thick at disk, thin toward margin, spongy; *gills* free, close to stem, white, drying a flesh color with darker rosy and vinaceous shades, 6-8 mm. broad, edges even to slightly serrate; *stem* 7-10 cm. long, 1.0-1.5 cm. broad, tapering upward, smooth above and below, white, changing chocolate brown where handled, hollow, stuffed sparingly with silky fibrils; *annulus* membranous, reflexed, below the middle of stem, white changing chocolate when bruised; *spores* smooth, white, $6-7 \times 4 \mu$; ellipsoid-ovate; *taste* mild; odor farinaceous.

Solitary, in open pastures, near Peoria, November.

This species is close to *L. americana* and very close to *L. Badhami*. From the description (8) of the latter, it differs in color of the pileus and flesh when bruised, and the gills are close to the stem.

22. *LEPIOTA RHACODES* (Vitt.) Fries.

Under frondose trees, Portland and Salem. October and November. In Oregon State College Herb. No. 5573, and 5660, and also distributed to Farlow Herb., Harvard University; The New York Botanical Garden Herb.; University of Michigan Herb.; and Missouri Botanical Garden Herb.

This Oregon material seems in every detail like the plant described in Europe. The colors are between those shown by *Bresadola* (1) and *Ricken* (9) and the spores are ovate, appear truncate at the distal end because of a germ pore (as also described for *L. brunnea* Farl. and Burt (2)), and measure $9-12 (12.3) \times 6-7 \mu$. The one specimen sent in from Portland measured 22 cm. in diam. and 24 cm. tall.

Since *L. Brunnea* Farl. and Burt, the only American type previously referred to *L. rhacodes*, has proven to be a distinct species, the Oregon collections perhaps constitute the first actual report of this European species in North America. Because the New England species had previously been referred to *L. rhacodes*, I thought it desirable to report above the distribution of parts of an Oregon collection in eastern herbaria.

23. *LEPIOTA ROSEIFOLIA* Murrill.

In mixed woods, Alsea Mt., Benton County. October and December.

This species has many characteristics in common with *L. flammeatincta* Kauffman, and further experience may prove them to be the same. My collections have the bitterish taste; annulus white above and tawny below; pileus 6 cm. in diameter, flaming red when touched or bruised, the whole becoming very dark when dry; the flesh and gills, however, changing pink when cut or bruised. The spores are $7-9 \times 4 \mu$.

24. *LEPIOTA ROSEILIVIDA* Murrill.

In mixed woods, Alsea Mt., Benton County. October. Infrequent.

Previously reported from Muirs Woods, California.

25. *LEPIOTA SEQUOJARUM* Murrill.

Under *Pseudotsuga taxifolia*, in open woods, near Lebanon, Linn County. October. Solitary.

This delicate species is easily characterized by the white pileus

with isabelline umbo. The spores in ours are ovate to ellipsoid, $7-8.8 \times 3.5-4 \mu$. The stem is slender, 12 cm. long and 4 mm. thick. This is the first report of this species north of Muir Woods.

26. *LEPTONIA FULIGINOSA* Murrill.

In lawns, Corvallis. September to April. Common.

Described from Palo Alto, California.

27. *Naucoria alniphila* sp. nov.

Gregaria: pileo 4-8 (10) cm. lato carneo campanulato-convexo dein expanso et umbonato, viscido levi vel innato-fibrilloso, centro furfuraceo-fibrilloso, radiatim squamas innatas, margine translucido roseo-ochraceo, umbone fulvo-olivaceo vel badio; stipite 4-7 (8) cm. longo, 3-7 mm. crasso, pileo concolore vel sordido brunnescento, subaequali primo albo sericeo-fibrilloso veli reliquiis fibrillosis fugocibus consperso, dein sericeo-striato; lamellis adnatis vel raris sinuatis discretans leniter distans, 4-6 mm. crassis albo-fuscis vel ferrugineis; sporis ferrugineis ellipsoideis vel ovoideis, levis $5-7 \times 3-4.5 \mu$; cystidiis numerosis in superficie et in acie lamellarum, hyalinis capitato-lecythiformibus obtusis $50-60 \times 14-18 \mu$.

Ad truncos et ramulos emortuos et procumbens Alni, Alsea Mons, Oregon, Amer. bor. (S. M. Zeller).

Pileus 4-8 (10) cm. broad, fleshy, campanulate to hemisphaerical, then expanded, umbonate, smooth to innate-fibrillose, furfuraceous-fibrillose on umbo from which innate scales of similar surface radiate, viscid when wet, a translucent pinkish buff on the margin to darker toward the disk, umbo and scales tawny-olive to warm sepia; *stem* 4-7 (8) cm. long, 3-7 mm. diam., concolorous or dingy becoming brownish, equal or thickened upwards, silky or striate with scattered oppressed fibrils, when young sprinkled with white, silky fibrils, the remains of a rather ample, fugaceous *veil*; *gills* adnate to rarely sinuate, separating, moderately distant, 4-6 mm. broad, whitish fuscous, then ferruginous; *spores* ferruginous, broadly ellipsoid to ovoid, variable in size, $5-7 \times 3-4.5 \mu$, smooth; *cystidia* numerous in hymenium and thickly set on edge of gills, all hyaline, capitate-flask-shaped, blunt, $50-60 \times 14-18 \mu$.

Abundant on logs of *Alnus rubra*, Alsea Mt., Benton County, November to December. Frequent.

This fungus is extremely plentiful wherever found. The down logs at a distance appear distinctly spotted with them. The sporophores come singly but gregarious over the whole extent of the log or brush supporting them. They have been found by the writer on nothing but alder bark on trunks or stems which were cut not more than a year.

28. NAUCORIA ESCHAROIDES Fries.

Under alders in damp soil, Rhododendron, and frequently along creek bottoms. September to November. Common. Collected and identified by J. E. Lange and the writer. Unmistakeably the same as described by Rea (8) in England.

29. *Naucoria oregonensis* sp. nov.

Gregaria: pileo 2-6 cm. lato primito campanulato (saepae margine introrse revoluto vel contracto) dein expanso vel subplano subumbonato; superficie sicco levi appresso-fibrilloso squamoso, centro "buckthorn brown" vel "Dresden brown," margine "pinkish buff" vel "tawny-olive," siccans "cinnamon-buff" vel "buffy brown" (10), contextu tenui albido vel cremeo; stipite 4-7 cm. longo, 7-10 mm. crasso cartilagineo firmulo vel fibroso-farcto albo vel cremeo levi subaequali; lamellis adnatis crassis ventricosus a fronte leniter crassioribus, confertis insertis, "clay color" vel "tawny olive" siccans "tawny olive" vel "Saccardo's umber" (10), hygrophanis acie subciliatis, pallidioribus; basidiis clavatis $25-29 \times 6-7 \mu$; sporis ochraceis variabilis, fusiformis elongatis-ovoideis vel inaequalis-ellipsoideis, $9-13 \times 4-6 \mu$; cystidiis subnumeriosis in superficie et in acie lamellarum, hyalinis variabilis longis-clavatis pyriformis, in apice interdum late rotundatibus vel mucronatibus, levibus vel verrucosibus, $50-60 \times 6-10 \mu$ protrudens $25-42 \mu$.

Plerumque circinatim ad terram in pratis, Coast Range, Benton County, Oregon, Amer. bor. (*S. M. Zeller*).

Pileus 2-6 cm. broad, at first campanulate (often with incurved or constricted margin) then expanding to nearly plane, subumbonate; *surface* squamose with appressed fibrillose scales, dull, dry, "buckthorn brown" to "Dresden brown" at the center and "pinkish buff" to "tawny-olive" at the margin, drying "cinnamon-buff" to "buffy brown"; *flesh* whitish to creamy, thin; *stem* 4-7 cm. long, 0.7-1.0 cm. thick, cartilaginous, solid to fibrous-stuffed, white to creamy, smooth, nearly equal; *gills* adnate, broad, ventricose, unequal, slightly wider in front, close, "clay color" to "tawny-olive," drying "tawny-olive" to "Saccardo's umber" (10), hygrophanous, margins lighter and almost ciliatulate due to the hyaline sterile cells; *basidia* clavate, $25-29 \times 6-7 \mu$; *spores* fusiform, elongate-ovoid to unequilateral-ellipsoid, $9-13 \times 4-6 \mu$, ochraceous ("clay color" to "tawny-olive" in mass); *cystidia* quite numerous, cylindro-clavate, hyaline, broadly rounded and mucronate to verrucose at tip, $50-60 \times 6-10 \mu$ (projecting $28-35 \mu$); *sterile cells* at margin of gills very much like cystidia, tips mostly smooth, some verrucosely-capitate, some pyriform, hyaline, projecting $24-42 \mu$, mostly $9-10 \mu$ in diameter.

In pasture lands which have never been cultivated, forming "fairy rings" or "arcs" of rings, gregarious. Elevation 1000-

1500 ft. Common in hills of the Coast Range in Oregon. Type collected on divide between Wren and Kings Valley, Benton County. November and December.

30. *NAUCORIA PELLUCIDA* (Bull.) Quél.

On soil in the crowns of cultivated brambles and on the soil around orchard trees. Common throughout western Oregon during any period when the temperatures are nearly freezing. Through the winter from October to March.

This is the first report of this species from the northwest. In ours the spores are $7-9 \times 3.5-5 \mu$ but in every other way agrees with descriptions and illustrations by Europeans. (Ricken and Rea).

31. *NOLANEA MAMMOSA* Fries.

Growing from small bits of decayed wood in mixed woods, Alsea Mt., Benton County. October. Frequent.

Since first identifying this species it has been found generally in our mixed woods, especially under maple, hemlock, or dogwood. It is a beautifully trim species. The spores of ours measure between those given by Bresadola, Rea, and Ricken, mostly $11-14 \times 7-8 \mu$.

32. *NOLANEA PASQUA* Fries.

Under conifers, near Hemlock, Tillamook County. September. Rather common in Oregon but not often found in the Eastern U. S. Has characteristically 4-angled spores.

33. *PAXILLUS PANUOIDES* Fries.

On logs of *Pinus contorta*, Taft, Lincoln County. Very infrequent. November.

This is the first report of this species from Oregon although it has been collected in Washington and California.

34. *Pholiota scabella* sp. nov.

Solitaria: pileo convexo vel plano-expanso 6-10 cm. lato, sicco squamoso vel subsquarroso nitente, cute separabili, ochraceo, quia directonis lucis variabili "buff" vel "Dresden brown" (10); carne 8-12 mm. crassa alba vel cremea; lamellis adnatis in lineis solum decurrentibus, subaequalibus a fronte angustioribus, 4-5 mm. crassis, confertis, "Saccardo's umber" vel "sepia" (10), in acie undulatis; stipite radicato 7-9 cm. longo, 1.5-2.0 cm. crasso, robusto, subaequali vel sursum leniter tenuito solido intus albido decorum squamoso, cremeo tactu ochraceo vel obscuriore sursam squarroso albido-luteo; annulo membranaceo persistenti mediano deflexo 3-4 mm. lato, quia sporis fuscescens; basidiis hyalinis clavatis, 4-sporis, $16-18 \times 5-6 \mu$;

cystidiis sparsis truncato- vel mucronato-clavatis, hyalinis $28-35 \times 7-10 \mu$; sporis lato-ellipsoideis purpureo-brunneis $5-7 \times 3-4 \mu$; sapore acri-amaro, odore qualis rami nonnullus salicinus fractus.

Ad terram in silvis coniferis prope Lebanon, Oregon, Amer. bor. (S. M. Zeller).

Plants solitary, radicate; *pileus* hemisphaeric to plano-expanded, 6-10 cm. diameter; *surface* dry, squamose to subsquarrose, shiny, with pellicle which peels off, ochraceous, buff to Dresden brown according to angle of light; *flesh* thick, 8-12 mm. thick, white to creamy; *gills* adnate with a striate line on the stem (not a tooth), Saccardo's umber to sepia, narrow, 4-5 mm. broad, narrower in front than behind, almost equal, close (not crowded), edges wavy; *stem* radicate, 7-9 cm. long, 1.5-2.0 cm. thick, stout appearance, almost equal, slightly tapering upward, solid and whitish within, squamose scaly below annulus, squarrose above, ivory yellow above, cream-buff below staining ochraceous-buff or darker where bruised; *annulus* membranous, persistent, 3-4 mm. broad, median, deflexed, colored by the purplish-brown spores; *basidia* hyaline, 4-spored, clavate, $16-18 \times 5-6 \mu$; *cystidia* rare, truncately to mucronately clavate, hyaline, $28-35 \times 7-10 \mu$; *spores* broad ellipsoid purplish-brown, $5-7 \times 3-4 \mu$. *Taste* bitterish acrid. *Odor* like certain green crushed stems (willow-like).

In dense coniferous woods, near Lebanon. October. Infrequent.

This species must be similar to *Stropharia sienna* Kauffman, but differs in surface of the pileus, colors, spores and annulus. Although the cap is dry, its shiny rough surface gives it a changeable color at various angles of light. The colors range from golden hues to dark dull brown. Close to *Pholiota duroides* Peck. For those who segregate species having scaly stems into the genus *Hypodendrum*, this becomes *Hypodendrum scabella* Zeller.

35. PLEUROTUS LIMPIDUS Fries.

On *Alnus*, near Hemlock, Tillamook County. September. Determined by Jakob E. Lange.

36. PSALLIOTA AUGUSTA Fries.

Under very dense *Pinus contorta* and *Picea* spp., between Waldport and Yachats, Lincoln County, Corvallis, Benton County, and Tillamook County. August to December. Frequent.

P. augusta is closely allied to *P. subrufescens* which also occurs in western Oregon. The latter has smaller spores, $6-7 \times 4-5 \mu$, and the gills are white at first, then pink becoming black-brown.

In *P. angusta* the spores are $8-12 \times 4-7$ (14×7.5) μ , and the gills are white at first, then gray becoming black-purplish-brown.

37. *Psalliota cervinifolia* sp. nov.

Gregaria vel caespitosa: pileo 10-20 cm. lato hemisphaeroido vel convexo-expanso, disco fusco, squamulis subdensis minutis fibrillosis fuscis appressis vestito, saepe margine levi et pallidiore, dein saepe squamulis ampliore consperso, tactu lutescens; contextu albo tactu lutescens postice crasso, margine tenui, odore et sapore grato; lamellis liberis subcrassis (15 mm. cr.) confertis "light vinaceous fawn" dein cervinis vel cinnamomeis et brunneolonigris; stipite 8-16 cm. longo 2-3.5 cm. crasso subaequali leniter bulboso, farcto dein cavo, prope lamellarum glabro vel leniter innato-fibrilloso, demum albo-griseo vel "light mouse gray" (10), tactu obscuriore rubro-brunneo annulo supero collarioideo, 4-8 mm. lato, simplici persistenti albo tactu brunnescens: sporis oblongis vel ovoideis levis purpureo-brunneis $4 \times 5-6$ (7) μ .

Ad terram fimatam ad margini silvarum coniferarum, Lincoln et Linn counties, Oregon Amer. bor. (*S. M. Zeller*).

Pileus 10-20 cm. broad, hemisphaeroid to convex expanded, fuscous on the disk, covered by rather dense, small fibrillose, fuscous, appressed scales, sometimes almost glabrous toward margin and paler, sometimes breaking into larger scales at maturity, yellowish when bruised; *flesh* white turning slightly yellowish when bruised, thick on disk, thin on margin; *gills* free, moderately broad (up to 15 mm. broad at maturity), crowded, pale vinaceous fawn at first, then fawn to cinnamon-drab, finally bone brown (dark purplish brown); *stem* 8-16 cm. long, 2-3.5 cm. thick, subequal, slightly bulbous, stuffed then hollow, glabrous to slightly innate-fibrillose near the gills, whitish gray to light mouse gray when older, darker reddish brown where handled; *annulus* superior, collar-like, 4-8 mm. broad, persistent, white to stained brownish where bruised, simple; *spores* mostly $4 \times 5-6 \mu$ (rarely 7μ), oblong to ovoid, purplish brown, smooth; *odor* and *taste* pleasant.

Gregarious to caespitose. In very fertile soil in the margins of coniferous forests where horses had been pastured. Linn and Lincoln counties, Oregon. November. Infrequent.

This plant has relationships to *P. haemorrhodaria* Fries, *P. sanguinaria* Karst. (*sensu* Lange), and *P. silvatica* Fries (*sensu* Bresadola), but is larger than these and differs in the color of the pileus and gills, and in characters of the annulus.

The specific name is given for the fawn color of the gills at medium development.

38. *PSALLIOTA DULCIDULA* Schulz.

In mixed woods among moss, *Rhododendron*. September. Solitary. Infrequent.

Characterized by the whitish cap with light brownish disk, pallid grayish gills which become almost black, yellowish stains on the stem, and the small size of the entire plant. It has not been previously reported from this country unless it is the same as *P. comptuloides* Murrill. The latter, however, seems stouter and the annulus larger.

39. *PSALLIOTA SUBRUTILESCENS* Kauffm.

In dense mixed woods, Alsea Mt., Benton County. November. Frequent. This relatively new species is not uncommon in the woods of the Coast Range as well as the Cascade Mountains (5).

40. *RUSSULA FALLAX* Fries.

Low damp places in woods, *Rhododendron*, Clackamas County. September. Collected by J. E. Lange and the writer. Frequent.

This species was previously reported from the west by Kauffman (5). The plants we observed were sordid purplish, almost black somewhat olivaceous on the disk but soon fading at maturity to sordid whitish; flesh white, acrid to peppery. The Pacific Coast plants evidently are not so light colored as Kauffman reports from Michigan but more nearly as Lange describes in Denmark.

41. *RUSSULA FURCATA* Fries.

In mixed woods, Newport. October. Infrequent.

This green *Russula* as found in Oregon, is in nearly every particular as described by European workers. The spores are $7-8.5 \times 5.3-6$ and the colors of the cap are exactly as shown by Bresadola (5, *pl.* 404) for well expanded specimens. Some of ours are "tawny-olive" at the disc and "Roman green" (10) nearer the margin.

42. *STROPHARIA PSATHYROIDES* Lange.

In moss under *Alnus*, near Beaver, Tillamook County. September.

This plant was observed in the field by Prof. Jakob E. Lange and the writer. According to Prof. Lange this is the first report of the species outside of Denmark (7).

43. *TRICHOLOMA AMPLUM* (Pers.) Rea.

In large clumps along roadside in open mixed woods, about 1 mile south of Helmick Park, Polk County. November. Uncommon.

Our plant is the same as described and illustrated by Bresadola (1), but not *sensu* Ricken (9).

44. *TRICHOLOMA CALIFORNICUM* Murrill, *Mycologia* 5: 223. 1913.

Syn. *Armillaria subannulata* Peck, Bull. Torrey Club 36: 330. 1909.

Melanoleuca californica Murrill, *Mycologia* 5: 216. 1913.

Melanoleuca subannulata (Peck) Murrill, N. Am. Flora 10: 30. 1914.

Tricholoma subannulatum (Peck) Zeller, *Mycologia* 14: 187. 1922. [Not *T. subannulatum* Batsch. See Bresadola (1, pl. 63).]

In lawns and heavy trodden soil under deciduous trees, Corvallis.

This species appears late in the fall each year in the same location where I first studied it in 1922. Since then I have watched the plants with interest and find several characters which were not included in previous descriptions. The taste is mild but not pleasant and the odor though usually farinaceous is often musty. The rugose character of the gills previously mentioned (1922) is very apparent in older specimens. Besides the transverse striations there are also frequently ridged veins on the gills radiating from the point of attachment to the stem. The spores are broadly ellipsoid, $5-7 \times 3.5-4.5 \mu$ (mostly 5×3.5) but with one large oil drop so large and conspicuous that at times all of the spores in a microscopic mount might easily be observed as spherical but a good lens will reveal the much less distinct cell wall.

This species has already been roughly handled by mycological taxonomists under the names appearing above, but since *Tricholoma subannulatum* Batsch is applied by some European mycologists to another plant, this Pacific Coast plant is listed here as *T. californicum* Murrill.

45. *TRICHOLOMA IONIDES* (Bull.) Fries.

In open lawns and pastures; common throughout the Willamette Valley. October to December.

This species forms "fairy rings" but does not stimulate growth of grass like *T. sordidum* and *Marasmius oreades*.

46. *TRICHOLOMA SORDIDUM* (Schm.) Fries.

In lawns, Corvallis. November to January.

This is difficult to distinguish from some of the other purplish-lilac species of *Tricholoma* but the rosy spores are characteristic and in Oregon it forms "fairy rings" in lawns. On the campus of the Oregon State Agricultural College are numerous fairy rings resulting from lawn infections by *Marasmius oreades* but there are also several rings resulting from *T. sordidum*. The grass is killed out at the margins by both fungi but the stimulated growth of grass following *Marasmius oreades* is more extreme than that following *T. sordidum*.

47. *TRICHOLOMA SUBPESSUNDATUM* Murrill.

In mixed woods and under conifers, Alsea Mt., Benton County, and Newport, Lincoln County. Frequent. October to December.

This species is very similar in appearance to *T. californicum* Murrill but differs in color of pileus and gills, and in the shape of spores.

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NOTES ON SOME SPECIES OF COLEO- SPORIUM—III

GEORGE G. HEDGCOCK AND N. REX HUNT

This paper is a continuation of a series, the first numbers of which were printed in 1922.¹ In the earlier papers, the following species of *Coleosporium* were considered: *C. delicatulum*,² *C. Helianthi*, *C. inconspicuum*, *C. Ipomoeae*, *C. ribicola*, *C. Solidaginis*, and *C. terebinthinaceae*. It was shown that these species are distinct from one another in their uredinial and telial host affinities, and their aecial morphology.

In 1920³ it had been shown that the aecial forms hitherto classed under *Coleosporium carneum* belonged to two distinct species, and *C. Elephantopodis* was set apart from *C. carneum*. Much of the data from inoculations with these two species have never been published and will be given in this paper.

1. COLEOSPORIUM CARNEUM

From 1913 to 1920, 135 sets of inoculations were made with aeciospores of *Coleosporium carneum* collected from 13 species of pine. Of these sets of inoculations, 18 were made with aeciospores taken from the needles of *Pinus caribaea* More., 20 from *P. echinata* Mill., 30 from *P. palustris* Mill., 43 from *P. taeda* L., and 24 from other species. 1037 plants of 7 species of *Vernonia* were inoculated, of which 220 plants of all 7 species were infected. Mature uredinia were produced in 11 to 15 days, and mature telia in about two months. In addition, 817 plants of 79 species of *Aster*, *Amsonia*, *Campanula*, *Coreopsis*, *Elephantopus*, *Eupatorium*, *Euthamia*, *Heterotheca*, *Ipomoea*, *Laciniaria*, *Parthenium*,

¹ Hedgcock, G. G., and Hunt, N. R. Notes on some species of *Coleosporium*—I, II. *Mycologia* 14: 244-257, pl. 20, 21, 297-310, pl. 22, 23. 1922.

² The nomenclature for rusts is that followed by Dr. J. C. Arthur, in *Uredinales*. N. A. Flora, Vol. 7. 1907, 1924, 1927.

³ Hedgcock, G. G., Hahn, G. G., and Hunt, N. R. New species and relationships in the genus *Coleosporium*. *Mycologia* 12: 182-198. 1920.

Pharbitis, *Quamoclit*, *Senecio*, *Silphium*, *Solidago*, and *Verbesina* were inoculated without infection.

In all the inoculation experiments given in this paper an equal number of plants were set aside as a control and remained free from infection. All the experiments were conducted in the greenhouses of the United States Department of Agriculture in Washington, D. C. The records and data are filed for consultation in the card catalogue of the Division of Forest Pathology.

From 1913 to 1920, 12 sets of inoculations were made with the urediniospores of *Coleosporium carneum* obtained from 3 species of *Vernonia*. 40 plants were inoculated, 8 plants of species of *Aster*, 2 of *Coreopsis*, 2 of *Euthamia*, 7 of *Heterotheca*, 9 of *Solidago*, 4 of *Verbesina*, and 8 of *Vernonia*. 7 plants of *Vernonia* were infected bearing uredinia and telia. The plants of the other species remained free from infection.

From 1913 to 1920, 5 sets of inoculations were made with the sporidia from germinating teliospores of *Coleosporium carneum*, chiefly in the month of September. 86 trees of 24 species of pine were inoculated. 27 trees of 10 species were infected, bearing pycnia from the following December to February, and aecia from February to April. Aeciospores from these trees were used in the inoculations previously given. *Pinus contorta* Loud. and *P. ponderosa scopulorum* Engelm. are now reported for the first time as proven hosts for pycnia and aecia.

2. COLEOSPORIUM ELEPHANTOPODIS

From 1914 to 1920, 46 sets of inoculations were made with the aeciospores of *Coleosporium Elephantopodis* collected from 8 species of *Pinus*, 13 from *P. caribaea*, 16 from *P. palustris*, 11 from *P. taeda*, and 6 from other species. 98 plants of 3 species of *Elephantopus* were inoculated, of which 74 plants were infected, bearing mature uredinia in 11 to 13 days and telia in about two months. 220 plants of 54 species of *Aster*, *Coreopsis*, *Euthamia*, *Helianthus*, *Heterotheca*, *Ipomoea*, *Laciniaria*, *Parthenium*, *Pharbitis*, *Senecio*, *Silphium*, *Solidago*, *Vernonia*, and *Verbesina* were inoculated at the same time without infection.

From 1914 to 1919, 10 sets of inoculations were made with the urediniospores of *Coleosporium Elephantopodis* collected from 3

species of *Elephantopus*. 73 plants of 3 species of *Elephantopus* were inoculated. Of these, 51 plants were infected bearing uredinia and telia. 31 plants of 1 species of *Heterotheca*, 2 of *Solidago*, and 4 of *Vernonia* were inoculated at the same time without infection.

From 1915 to 1920, 7 sets of inoculations were made, chiefly in September, with the sporidia from teliospores of *Coleosporium Elephantopodis*, from 7 collections on 2 species of *Elephantopus*. 150 trees of 25 species of *Pinus* were inoculated. Of these 43 trees of 8 species were infected, bearing pycnia from the following December to February, and aecia from February to April. Aeciospores from the trees were used in the inoculations previously given.

3. COLEOSPORIUM LACINIARIAE

From 1915 to 1919, 10 sets of inoculations were made with the aeciospores of *Coleosporium Laciniariae* collected from 3 species of *Pinus*. 37 plants of 7 species of *Laciniaria* were inoculated, of which 17 plants of 6 species became infected, bearing uredinia in 15 days and telia in about two months. At the same time, 94 plants of 26 species of *Aster*, *Coreopsis*, *Elephantopus*, *Euthamia*, *Helianthus*, *Heterotheca*, *Parthenium*, *Pharbitis*, *Silphium*, *Solidago*, *Vernonia*, and *Verbesina* were inoculated without infection.

In 1915, two sets of inoculations were made with the urediniospores of *Coleosporium Laciniariae* taken from the leaves of *Laciniaria graminifolia*. 10 plants of 6 species of *Laciniaria* were inoculated, of which 6 plants were infected, bearing mature uredinia in 15 days, and telia in two months. At the same time, 15 plants of 7 species of *Coreopsis*, *Helianthus*, *Heterotheca*, *Silphium*, and *Solidago* were inoculated without infection.

4. COLEOSPORIUM HETEROTHECAE

The senior writer has studied and collected for several years a form of *Coleosporium* occurring very commonly and abundantly on *Heterotheca subaxillaris* in Florida. In previous publications ⁴ this plant was wrongly referred to as *Chrysopsis mariana*, and wherever the latter name was used in giving the results of inoculations with various species of *Coleosporium* the former name should

⁴ L. c. 1 and 3.

be substituted. A meager specimen of a species of *Peridermium* on the needles of *Pinus palustris* differing from any previously described form, was found in Florida, closely associated with this *Coleosporium* but no inoculations have been made to prove its relation, if any, to it. This *Coleosporium* maintains itself very effectively by wintering over on the rosettes of the host species, a habit common to several species of *Coleosporium* in the southern states. At first this form was doubtfully assigned to *Coleosporium Solidaginis*, but all attempts to prove its relationship to this and to other species of the genus have failed.

In testing the susceptibility of *Heterotheca subaxillaris* to species of *Coleosporium* from 1915 to 1920, 110 plants in fine growing condition were inoculated with the aeciospores of 8 other species of *Coleosporium*, as follows: 17 with *Coleosporium carneum*, 7 with *C. delicatulum*, 15 with *C. Elephantopodis*, 10 with *C. Helianthi*, 14 with *C. inconspicuum*, 14 with *C. Ipomoeae*, 13 with *C. Laciniariae*, and 20 with *C. Solidaginis*. All the plants inoculated remained free from infection.

The urediniospores of 6 species of *Coleosporium* were also used during the same period to inoculate 28 plants of *Heterotheca subaxillaris* as follows: 6 with *Coleosporium carneum*, 6 with *C. Elephantopodis*, 5 with *C. Helianthi*, 3 with *C. Ipomoeae*, 4 with *C. Laciniariae*, and 4 with *C. Solidaginis*. All the plants inoculated remained free from infection.

Two sets of inoculations were made in 1926 with the urediniospores of the *Coleosporium* from *Heterotheca subaxillaris* on 63 plants of 12 species known to be susceptible to species of *Coleosporium*. The following plants were inoculated: 3 of *Aster paniculatus*, 8 of 2 species of *Coreopsis*, 6 of *Elephantopus carolinianus*, 10 of 2 species of *Helianthus*; 10 of *Heterotheca subaxillaris*, 8 of 2 species of *Solidago*, 9 of *Verbesina laciniata*, and 9 of 2 species of *Vernonia*. Eight plants of *Heterotheca subaxillaris* were infected, bearing uredinia in about 15 days, but the leaves were shed before mature telia were formed. All the other plants inoculated remained free from infection. The *Coleosporium* from *Heterotheca subaxillaris* is now described as a new species.

Coleosporium Heterothecae sp. nov.

Soris uredosporiferis hypophyllis, subinde etiam epiphyllis, sparsis vel aggregatis, rotundatis vel ellipsoideis, 4.5–7 mm. crassis max nuclis, pulverentis aurantiacis, dein pallida flavis; unredosporis globosus, ovatis, vel ellipsoideus, verrucosis, $16\text{--}24 \times 11\text{--}16 \mu$, episporio hyalino $0.7\text{--}1.5 \mu$ crasso.

O and I Pycnia and aecia unknown.

II. Uredinia usually hypophyllous, sometimes epiphyllous, few to very numerous, small, circular to elliptic in outline, $0.45\text{--}0.7^5$ mm. across, averaging 0.6 mm., orange chrome fading with age to nearly white; urediniospores sphaeroid to ovoid or ellipsoid, $11\text{--}16$ by $16\text{--}24 \mu$, averaging 13 by 19μ , with walls slightly thickened at the apex, $0.7\text{--}1.5 \mu$ in diameter, averaging 1μ , verrucose with small conical tubercules.

Type collection on *Heterotheca subaxillaris* (Lamb.) Britton from East Mayport, Florida, collected by G. G. Hedgcock March 11, 1916. Known only from Florida. No mature telia have been collected.

Heterotheca subaxillaris was formerly called *Inula subaxillaris* Lamb. *Coleosporium Inulae* Rabh. occurs on *Inula Vaillantii* and plants of other genera in Europe, Asia, and Africa. The urediniospores of this species are $17\text{--}23 \mu$ by $20\text{--}35 \mu$; those of *Coleosporium Heterothecae* are $11\text{--}16 \mu$ by $16\text{--}24 \mu$, being much narrower and considerably shorter.

DIVISION OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

⁵ Based on 100 measurements.

RUSTS OF THE NORTHWEST HIMALAYAS ¹

J. C. ARTHUR AND GEORGE B. CUMMINS

(WITH 2 TEXT FIGURES)

The Uredinales reported in this paper were collected by Dr. R. R. Stewart in the Northwest Himalayas. The species listed here were collected in India, in the Punjab, Kashmir, the Northwest Frontier Province and in the neighborhood of Mussoorie in the United Provinces (FIG. 1).

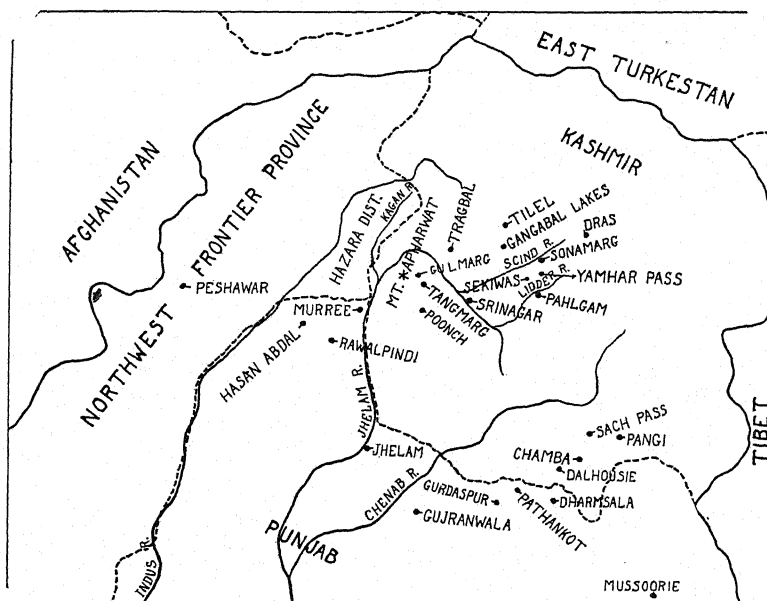


FIG. 1. A map of northern India to show the region in which Stewart collected the rusts reported in this paper.

This list contains 89 species comprising 165 collections, including 5 new species and 2 new combinations. There are 20 species of rusts marked with a double asterisk and 34 species of hosts in

¹ Contribution from the Botany Department, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

addition to those given with new records of Indian rusts, marked with a single asterisk which are not recorded by Butler and Bisby in "The Fungi of India," 1931, or by Sydow (Ann. Myc. 31: 84-88. 1933). Such species are considered to represent new records for India.

The writers wish to acknowledge their indebtedness to Dr. R. R. Stewart, collector, and to Dr. F. J. Seaver who transmitted for study that portion of Dr. Stewart's collections composed of rust fungi.

ACIDIUM CRYPTICUM Kalchbr. & Cooke, *Gerbera gossypina* Mussoorie, July 18, 1930, 11007; Murree Hills, Charial, Sept. 7, 1918, 4006.

*****Aecidium distinctum*** Arth. & Cumm., sp. nov.

Pycnia epiphylla, subepidermalia. Aecia hypophylla, maculis orbiculares usque 5 mm. diam. insidentia, gregaria, cupulata; cellulis peridii rhomboideae, 16-22 \times 24-30 μ , pariete exteriori 8-11 μ cr., striato, interiore 2-3 μ cr., verrucoso; aeciosporae globosae, 16-20 \times 18-24 μ ; episporio 1.5-2 μ cr., ad apicem usque 4-8 μ cr., hyalino, verrucoso.

On *Angelica glauca*, Tragbal, July 26, 1919, 4662.

ACIDIUM FLAVESCENS Barclay, *Senecio chrysanthemoides*, Pahlgam, Aug. 1920, 5900½; Sept. 6, 1920, 5955.

No material of Barclay's species has been available for comparison but Stewart's collection agrees with the published account. From a comparison of the aecia it seems probable that this species belongs with *Puccinia silvatica* Schröt., or a closely related form with telia on *Carex*.

ACIDIUM GIRARDINIAE Sydow, *Girardinia heterophylla*, Jabbar Khet, Mussoorie, June 2, 1930, 10821.

*****Aecidium Hederae*** Arth. & Cumm., sp. nov.

Pycnia amphigena, subepidermalia, tumores efficientia. Aecia hypophylla, 1-2 mm. lata, irregulariter disposita, cupulata; cellulis peridii cubiceae, 16-20 μ lata, partiere exteriori 3-4 μ cr., striato, interiore 2-3 μ cr., verruculoso; aeciosporae globosae, 12-16 μ diam., episporio 0.5-1 μ cr., hyalino, minute verruculoso.

On *Hedera himalaica*, Murree Hills, Punjab, June 1928, 10525 (type); Charehan, Murree Hills, May 28, 1920, 5202.

This species causes distortion of the leaves and petioles. The aecia are broadly cup-shaped with the peridium rupturing irregularly and breaking away at the surface of the host.

****AECIDIUM LOPHANTHI** P. Henn., undetermined mint, Alwas, Chamba, June 23, 1917, 2366.

In the type collection the apical thickening of the aeciospore-wall is more pronounced but otherwise the two collections agree well.

AECIDIUM MONTANUM Butler, **Berberis chitria*, Mussoorie, 1930, K. N. Gupta, 13279; *B. lycium*, Barian, May 27, 1929, 10219; Murree Hills, Punjab, June 1928, 10524; Dharmasala, Punjab, June 1929, 10249; *B. sp.*, Dalhousie, June 1, 1917, 2185.

AECIDIUM ORBICULARE Barclay, **Clematis connata*, Pahlgam, July 23, 1920, 5387½; *C. grata*, Changla Gali, Murree Hills, May 27, 1929, 10228; **C. montana*, Pahlgam, July 22, 1920, 5381; *C. sp.* Upper Chenab, July 13, 1917, 2865½.

This *Aecidium* morphologically is very like the aecia of *Puccinia rubigo-vera* (DC.) Wint., and may belong with that species.

****Aecidium Stewartii** Arth. & Cum., sp. nov.

Pycnia amphigena, subepidermalia. Aecia hypophylla, aequaliter denseque distributa, totam folii superficiem occupantia, cupulata; cellulis peridii rhomboideae, 18–22 × 23–28 μ, partiere exteriore 3–6 μ cr., striato, interiore 2–3 μ cr., verrucoso; aeciosporae ellipsoideae vel globosae, 20–26 × 24–31 μ, episporio 1.5 μ cr., pallide brunneo, verrucoso.

On *Justicia quinqueangularis* ?, Gurdaspur Dist. Punjab, Febr. 18, 1917, 1318.

AECIDIUM sp., *Lactuca* ?, Dalhousie, 7000 ft., June 13, 1917, 2232.

AECIDIUM sp., on *Epilobium roseum*, Upper Lidder Valley, Naf-ran, Aug. 1931, 12521.

The aecia are not systematic as in known autoecious species and may represent an undescribed form belonging to some heteroecious species.

CHNOOPSORA BUTLERI Diet. & Sydow, *Adhatoda vasica*, Pathankot, May 1917, 1698.

CHNOOPSORA SANCTI-JOANNIS (Barclay) Diet., **Hypericum lysimachioides*, Landour, Mussoorie, May 1931, 12603.

CHRYSOMYXA DEFORMANS (Diet.) Jacz., *Picea Smithiana*, Dalhousie, June 13, 1917, 2164½.

COLEOSPORIUM CAMPANULAE (Pers.) Lév., *Campanula canescens* Saidpur near Rawalpindi, Mar. 25, 1922, 6977.

COLEOSPORIUM CLEMATIDIS Barclay, *Clematis montana*, Gharial,

Murree Hills, Sept. 6, 1918, 4004; Ghora Gali, Murree Hills, Oct. 1931, 12397.

CRONARTIUM RIBICOLA (Lasch) Dietr., **Ribes orientale*, Gulmarg, Kashmir, Aug. 22, 1929, 10528.

GAMBLEOLA CORNUTA Massee, *Mahonia nepalensis*, Landour, Mussoorie, May 1931, 12522.

GYMNOSPORANGIUM CUNNINGHAMIANUM Barclay, **Cotoneaster bacillaris*, Landour, Mussoorie, Aug. 21, 1930, 11207.

****Gymnosporangium distortum** Arth. & Cumm., sp. nov. (FIG. 2, A & B).

Pycnia caulicola vel foliicola, subepidermalia. Aecia caulicola vel hypophylla, tumores efficientia et totam superficiem occupantia, 1–2 mm. alta, 0.5–1 mm. lata, fimbriata; cellulis peridii oblongae $16\text{--}20 \times 60\text{--}90 \mu$, partiere exteriore 3μ cr. levi, exteriore $8\text{--}12 \mu$ cr., rugoso vel papillato; aeciosporae ellipsoideae vel globosae, $20\text{--}24 \times 24\text{--}29 \mu$; episporio $2\text{--}2.5 \mu$ cr., cinnamomeo-brunneo, rugoso, poris germ. 6–8.

On *Cotoneaster bacillaris*, Tragbal, Kashmir, July 2, 1919, 4372 (type); Alwas, Chamba State, June 27, 1917, 2451; *C. rosea*, Gurais, July 1, 1919, 4314.

The infected twigs and leaves are considerably distorted and bear pycnia and aecia on the entire infected area. The peridium becomes finely fimbriate to the base. The peridial cells bear short ridges or elongate papillae on the inner surface and transversely across the lateral wall.

MELAMPSORA AECIDIIOIDES (DC.) Schröt., *Populus alba*, Nasim Bagh, Kashmir, July 1929, 10621.

MELAMPSORA HELIOSCOPIAE (Pers.) Wint., *Euphorbia helioscopia*, Pathankot, Febr. 12, 1917, 1130; *E. pilosa*, Sonamarg, Kashmir, Sept. 2, 1917, 3526, Sept. 5, 1917, 3602; Tragbal, Aug. 5, 1919, 4890; **E. Wallichii*, Mt. Apharwat, Kashmir, Aug. 15, 1929, 10471; above Gulmarg, Kashmir, Aug. 31, 1929, 10500A.

MELAMPSORA LARICIS-CAPREARUM Kleb., *Salix* sp., Dalhousie, June 11, 1917, 2180.

OCHROPSORA SORBI (Oud.) Diet., *Anemone* sp., Alwas, Chamba, June 26, 1917, 2431.

****OPLOPHORA CEDRELAЕ** (Hori) Sydow, *Cedrela serrata*, Kalel, Chamba, June 21, 1917, 2328.

PERIDERMIIUM BREVIUS (Barclay) Sacc., *Pinus excelsa*, Dharm-sala, May 22, 1917, 1962.

PERIDERMIMUM ORIENTALE Cooke, *Pinus longifolius*, Nadi, Dharmasala, May 25, 1917, 1994; Landour, Mussoorie, May 1931, 12485A.

PERIDERMIMUM PICEAE (Barclay) Sydow, *Picea Smithiana*, Dalhousie, June 9, 1917, 2164.

PHRAGMIDIUM BARCLAYI Diet., *Rubus lasiocarpus*, Tragbal, Kashmir, July 20, 1919, 4780.

This collection is so named with some hesitation. Epiphyllous, subcuticular pycnia are present accompanied by teliospores that germinate at once. No aecia or uredia are present. Future collections may show this to represent a distinct microcyclic species.

PHRAGMIDIUM BUTLERI Sydow, *Rosa macrophylla*, Changla Gali, May 27, 1929, 10212; above Gulmarg, Kashmir, Aug. 1929, 10641; Mussoorie, June 2-4, 1929, 10884; *R. sp.*, Dalhousie, June 13, 1917, 2229.

PHRAGMIDIUM DISCIFLORUM (Tode) James, **Rosa webbiana*, Sonamarg, Kashmir, Sept. 5, 1917; *R. sp.* Rawalpindi, Dec. 4, 1916, 368a.

Phragmidium Kamtschatkae (Anders.) Arth. & Cumm., comb. nov. (*Puccinia Rosae* Barclay, Jour. Asiatic Soc. Bengal 58: 233. 1889, not *Puccinia Rosae* Pers. Syn. Fung. 230. 1801, or Schum. Enum. Pl. Saell. 2: 235. 1803; *Puccinia Kamtschatkae* Anders. Jour. Myc. 6: 125. 1890; *Gymnoconia Rosae* Liro, Ured. Fennicae 413. 1908; *Teleconia Rosae* Sydow, Ann. Myc. 19: 168. 1921; *Phragmidium Rosae* Tranz., see E. & P. Nat.-Pfl. 2te Aufl. 6: 63. 1928, not *Phragmidium Rosae* Rostr. Plante-patologie 227. 1902).

On *Rosa* probably *R. Webbiana*, Gangabal Lakes, July 4, 1919, 4423.

Lindroth (Fauna Fl. Fenn. 20^o: XXIII. 1901) has pointed out that Barclay's name *Puccinia Rosae* is antedated, as is indicated in the synonymy given above. *Puccinia Kamtschatkae* Anders., becomes then the first valid name applied to this species. *Phragmidium Rosae* of Tranzschel is antedated by Rostrup's use of this combination for *Phragmidium disciflorum* (Tode) James. The fungus should, therefore, be called *Phragmidium Kamtschatkae*.

PHRAGMIDIUM POTENTILLAE (Pers.) Karst., *Potentilla fragarioides*, Alwas, Chamba, June 1917, 2386; **P. Kleiniana*, Poonch, Apr. 1, 1931, 13280.

PHRAGMIDIUM ROSAE-MOSCHATAE Diet., *Rosa moschata*, Dharmkot, Dharmsala, May 26, 1917, 2027; **R. macrophylla*, Alwas, Chamba State, June 27, 1919, 2444; *R. Webbiana*, Pahlgam, Sept. 4, 1920, 5892.

PUCCINIA ABSINTHII DC., **Artemisia sieversiana*, Lower Scind Valley, Kashmir, Sept. 7, 1922, 7467½.

**PUCCINIA AINSLIAEAE Sydow, *Ainsliaea pteropoda*, Jabberkhet, Mussoorie, Sept. 8, 1930, 11442.

**PUCCINIA ARGENTATA (Schultz) Wint., *Adoxa moschatellina*, Sonamarg, July 7, 1928, 9808.

PUCCINIA BARBEYI (Roum.) Magn., **Asphodelus tenuifolius*, Rawalpindi, Mar.-Apr., 1930, 13281.

PUCCINIA BUPLEURI-FALCATAE (DC.) Wint., **Bupleurum jucundum*, Sonamarg, July 27, 1922, 7209.

**PUCCINIA CALTHAE Link, *Caltha palustris* var. *alba*, Dharm-sala, May 1917, 1917½; (no locality given) July 1920, 5598; Pahlgam, Sept. 4, 1920, 5906.

PUCCINIA CHAEROPHYLLI Purt., **Chaerophyllum villosum*, above Gulmarg, Kashmir, 1929, 10364.

PUCCINIA CHRYSOPOGI Barclay, *Jasminum humile*, Alwas, Chamba, July 2, 1917, 2575½.

PUCCINIA CIRCAEAE Pers., *Circaea alpina*, Sonamarg, Aug. 31, 1917, 3453; var. *himalaica*, above Gulmarg, Kashmir, Aug. 19, 1929, 10494; var. *intermedia*, Sonamarg, Aug. 30, 1917, 3441.

PUCCINIA CORONATA Corda., **Elaeagnus umbellata*, Chenari, Kashmir, July 3, 1931, 12175; *Rhamnus virgatus*, Dharm-sala, May 31, 1917, 2071½; *R. purpureus*, Dalhousie, June 13, 1917, 2218; *R. virgatus*, Dharm-sala, May 26, 1917, 2008; Dalhousie, June 11, 1917, 2188; Kagan Valley, Hazara district, July 1-7, 1920, 6034.

PUCCINIA CREPIDIS-SIBERICAЕ Lindr., *Crepis sibirica*, Sonamarg, Kashmir, Aug. 23, 1921, 6777½.

PUCCINIA DUTHIAE Ellis & Tracy, **Andropogon ischaemum*, near Mogli Bungalow, Jhelam District, Punjab, Jan. 5, 1917, 747.

PUCCINIA EPILOBII-TETRAGONI (DC.) Wint., **Epilobium roseum*, Yamhar Pass, Kashmir, Sept. 1931, 12474A.

PUCCINIA EXCELSA Barclay, *Phlomis setigera*, Gulmarg, Kashmir, 1929, 10481.

PUCCINIA EXTENSICOLA Plowr., *Aster asperulus*, Mussoorie, July 19, 1930, 11008.

**PUCCINIA ? FESTUCAE Plowr., *Lonicera parvifolia*, above Gulmarg, July 30, 1926, 8636.

PUCCINIA GENTIANAE (Str.) Link., **Gentiana decumbens*, Tragbal, Kashmir, July 24, 1919, 4597.

PUCCINIA GERANII-SILVATICI Karst., **Geranium aconitifolium*, Gulmarg, Kashmir, 1929, 10506; **G. pratense*, Tilel, Kashmir, July 2, 1919, 4337, 4337½.

PUCCINIA GLUMARUM (Schum.) Erikss. & Henn., *Hordeum vulgare*, Nadi, Dharmsala, May 26, 1917, 2015.

PUCCINIA GRAMINIS Pers., **Berberis pseudumbellata*, Tangmarg, Kashmir, July 1931, 12226.

**PUCCINIA HERACLEI Grev., *Heracleum candicans*, Changla Gali, Murree Hills, Aug. 27, 1918, 3958; Mt. behind Srinagar, July 19, 1919, 4134; Sonamarg, July 27, 1922, 7204.

This collection differs somewhat from the usual collections of *P. Heraclii* in that the aeciospores are smaller, $15-20 \times 20-25 \mu$, but the aecia are badly parasitized. No other spore-form is present.

PUCCINIA HIERACII (Schum.) Mart., *Hieracium crocatum*, Sonamarg, Aug. 25, 1921, 6804.

PUCCINIA KOMAROWI Tranz., **Impatiens Thomsoni*, Tragbal, Aug. 7, 1919, 4868; Pahlgam, Sept. 6, 1920, 5952; Sonamarg, Aug. 15, 1921, 6662; Sonamarg, July 24, 1922, 7167; above Gulmarg, Kashmir, July 1929, 10651; *I. sp.*, Changla Gali, Murree Hills, Oct. 1924, 7693.

PUCCINIA MENTHAE Pers., *Mentha sylvestris*, Hasan Abdal, Dec. 6, 1916, 316; Gharial, Murree Hills, Sept. 7, 1918, 4024.

PUCCINIA MONTICOLA Kom., *Polygonum tortuosum*, Dras, Ladak, Kashmir, Aug. 31, 1922, 7426½.

PUCCINIA NEPALENSIS Barclay & Diet., **Rumex acetosa*, above Gulmarg, Kashmir, July 1929, 10652.

PUCCINIA NITIDA Barclay, **Polygonum flicale*, Gulmarg, Kashmir, Aug. 13, 1929, 10448.

**PUCCINIA OPIZII Bubák, *Lactuca* probably *decipiens*, Alwas, Chamba, July 3, 1917, 2651.

PUCCINIA PIMPINELLAE (Str.) Mart., *Pimpinella diversifolia*, Changla Gali, Murree Hills, Sept. 12, 1922, 4051.

PUCCINIA POLLINIAE Barclay, *Strobilanthes dalhousianus*,

Gharial, Murree Hills, Sept. 2, 1918, 3982; Murree, Sept. 4, 1918, 3990; Ghora Gali, Murree Hills, Oct. 1931, 12407; *S. sp.*, Dalhousie, June 7, 1917, 2126; Landour, Mussoorie, July 11, 1930, 10989.

PUCCINIA POLYGONI-AMPHIBII Pers., *Geranium Wallichianum*, Jabberkhet, Mussoorie, July 19, 1930, 11020; *G. sp.*, Purana Tilel, Kashmir, July 2, 1919, 4458.

**PUCCINIA PRAECOX Bubák, *Crepis kashmirica*, Sonamarg, Kashmir, Aug. 16, 1922, 7333½; Sonamarg, Kashmir, Aug. 11, 1928, 9884.

PUCCINIA PROPINQUA Sydow & Butl., **Andropogon ischaemum*, Topi Park, Rawalpindi, Dec. 4, 1916, 368.

PUCCINIA PRENANTHES-PURPUREAE (DC.) Lindr., **Lactuca ? decipiens*, Sonamarg, July 27, 1922, 7213.

**PUCCINIA PULSATILLAE Kalchbr., *Aconitum moschatum*, Tragbal, July 24, 1919, 4635; *Anemone tetrasepala*, above Gulmarg, Kashmir, Aug. 1926, 8753; Banehal Pass, July 1, 1931, 12216; *A. sp.*, Sonamarg, Sept. 5, 1917, 3607.

PUCCINIA RUBIGO-VERA (DC.) Wint., **Aquilegia pubiflora*, Murree Hills, Punjab, June 1926; *A. vulgaris*, Dharmasala, May 28, 1917, 2048; Dharmasala, May 1917, 2069; *A. sp.*, Pahlgam, July 1920, 5380; **Thalictrum minus*, Sach Pass, Chamba, July 3, 1917, 2662; Sonamarg, July 27, 1922, 7203; *T. sp.*, Pahlgam, Kashmir, July 22, 1920, 5353; *Triticum sp.*, Khangah Dogran, Gujranwala District, Mar. 11, 1917, 1447.

PUCCINIA SAXIFRAGAE-CILIATAE Barclay, *Saxifraga ciliata*, Alwas, Chamba, June 29, 1917, 2511; Murree Hills, May 27, 1929, 10215; **S. Stracheyi*, Sonamarg, Kashmir, Aug. 19, 1922, 7353; Mt. Apharwat, Kashmir, Aug. 12, 1929, 10408; Sekiwas, Upper Lidder Valley, Sept. 1931, 12523.

***Puccinia silvaticella* Arth. & Cumm., sp. nov. (FIG. 2, c).

Telia peiolata vel hypophylla, aggregata, confluentia, pulverulenta, cinnamomeo-brunnea; teliosporae oblongae, 16–20 × 28–40 μ, ad apicem rotundatae vel truncatae, ad basim attenuatae, medio leniter constrictae; episporio 1.5 μ cr., ad apicem 4–8 μ cr., castaneo-brunneo, levi; pedicello hyalino, sporam aequante vel brevior.

On *Taraxacum officinale*, above Gulmarg, Kashmir, Aug. 1926, 8744.

This species undoubtedly represents the correlated microform of

Puccinia silvatica Schröt. The micro-telia have the general habit of the aecia of the full-cycle species and the teliospores of both forms show a close similarity. Pycnia are not formed.

**PUCCINIA SWERTIAE (Opiz) Wint., *Swertia petiolata*, Mt. Apharwat, Kashmir, 1929, 10317; *S. speciosa*, above Gulmarg, Kashmir, 1929, 10433.

**PUCCINIA THLASPEOS Schub., *Draba lanceolata*, Hunan Nullah, Pangi, Chamba, July 9, 1917, 2773.

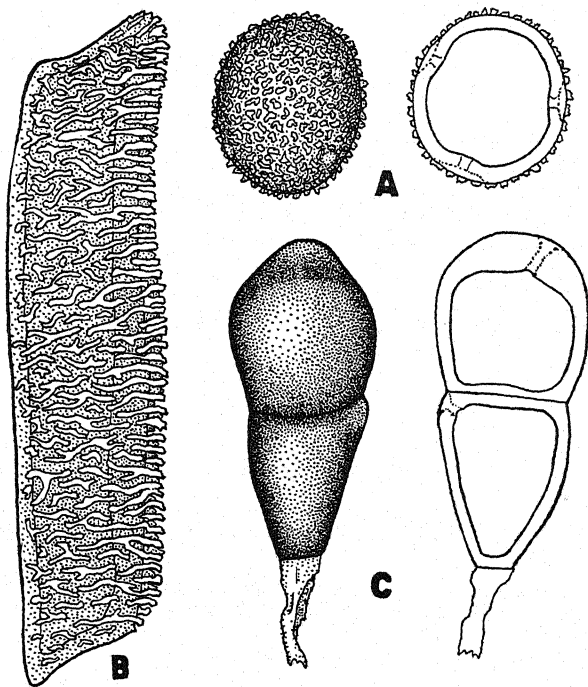


FIG. 2. A, these drawings in perspective and optical section show the rugose, relatively thick spore-wall of the aeciospores of *Gymnosporangium distortum*; B, a peridial cell of *G. distortum* illustrating the papillose to transversely ridged surface characteristic of the peridial cells of this species; C, perspective and optical section of the teliospores of the microcyclic species, *Puccinia silvaticella*. (Drawn with the aid of a camera lucida at a magnification of 1250 diameters.)

**PUCCINIA TROLLII Karst., *Anemone polyanthes* ?, Alwas Chamba State, June 27, 1917, 2437.

PUCCINIA CARICIS (Schum.) Schröt., *Urtica* sp. (no locality given), June 2, 1917, 2097.

PUCCINIA VIOLAE (Schum.) DC., **Viola biflora*, Pahlgam, July 22, 1920, 5350; *V.* sp., Sonamarg, Sept. 5, 1917, 3576½, 3604.

PUCCINIA WATTIANA Barclay, **Clematis grata*, Karel to Masrond Chamba, June 22, 1917, 2344½; Jhelam Valley Road, Kashmir, Sept. 15, 1917, 3779; Lidder Valley, Sept. 6, 1920, 5986.

PUCCINIOSTELE CLARKIANA (Barclay) Diet., *Astilbe rivularis*, Changla Gali, Murree Hills, May 27, 1929, 10213.

**UROMYCES ACONITI Fuckel, *Aconitum lycoctonum*, Sonamarg, July 21, 1921, 6358; Sonamarg, July 27, 1922, 7214.

UROMYCES ANDROPOGONIS-ANNULATI Sydow & Butler, **Andropogon ischaemum*, Khangah Dogran, Gujramwala District, Mar. 11, 1917, 1444.

**UROMYCES FRITILLARIAE (Schl.) Thüm., *Fritillaria Roylei*, above Gulmarg, Kashmir, July 1929, 10653.

UROMYCES GERANII (DC.) Otth & Wartm., **Geranium pratense*, Sonamarg, Kashmir, Aug. 8, 1928, 9868, 9868a; *G.* sp., Sonamarg, Kashmir, Aug. 19, 1922, 7401½.

**UROMYCES HEDYSARI-OBSCURI (DC.) Car. & Picc., *Hedysarum cachemirianum*, Sonamarg, Sept. 4, 1917, 3758.

UROMYCES POLYGONI (Pers.) Fuckel, *Polygonum aviculare*, Pahlgam, July 26, 1920, 5443.

UROMYCES SCIRPI (Cast.) Burr., *Scirpus* sp., Gurdaspur, Mar. 3, 1917, 1365.

UROMYCES TRIFOLII (Hedw. f.) Lév., *Trifolium resupinatum*, Islamia College, Peshawar, May 11, 1929, 10195.

Uromyces Valerianae-wallichii (Diet.) Arth. & Cumm., comb. nov. (*Uredo Valerianae-wallichii* Diet. Ann. Myc. 4: 303. 1906), **Valeriana pyrolaeifolia* (no locality given), Sept. 5, 1917, 3604½; *V. Wallichii* (no locality given), Sept. 5, 1917, 3577½; Tragbal, Kashmir, July 30, 1919, 4767; Changla Gali, Murree Hills, May 27, 1929, 10218; above Gulmarg, Kashmir, 1929, 10496.

Telia are present in three of the five collections accompanied by the characteristic urediospores. The telia are mainly epiphyllous, in small circinating groups or scattered, light chocolate-brown, pulverulent; teliospores globoid or obovoid, $21-25 \times 24-29 \mu$, usually rounded at both ends; wall $2.5-3 \mu$ thick, chestnut-brown, the pore apical; pedicel colorless, short, fragile.

STUDIES CONCERNING HETEROECIOUS RUSTS ¹

E. B. MAINS

The studies reported in this paper were made as opportunities and materials offered during the course of investigations of the leaf rust of the grasses, the results of which have been given elsewhere (1933). A number of the cultures were made possible through the kindness of the late Mr. E. Bethel, to whom the writer is specially indebted for material and clues concerning connections based on his discriminating field observations.

PUCCINIA MONOICA Arth.

In 1920, telia (10920) ² were received from Mr. Bethel who had collected them on *Stipa* sp. at Tuckee, California, August 27. These were found to be germinable and were sown September 1, 1920, on *Arabis* sp. and *Sidalcea candida*. No signs of infection were noted until May 10, 1921, when pycnia showed on the *Arabis*. The infected shoots of the *Arabis* were apparently filled with a systemic mycelium and the pycnia were widely distributed over the leaves of such shoots. Aecia developed about a week after the pycnia.

In the spring of 1921, aecia on *Arabis* sp. (Ara. 2) collected by Mr. Bethel May 25, 1921, at Boulder, Colorado, were sown on *Koeleria cristata*, *Stipa minor*, *S. pulchra*, and *S. viridula*. Infection was obtained only on *Koeleria cristata*.

Arthur (1912b) has reported that inoculations from aecia on *Arabis* sp. produced infection on *Trisetum spicatum* (*T. subspicatum*). *Koeleria cristata* and *Stipa viridula* gave negative results. In another experiment (1915) inoculations from aecia on *Arabis*

¹ Most of the cultures reported in this article were made while the writer was a member of the Department of Botany, Purdue Agricultural Experiment Station and the Office of Cereal Crops and Diseases, United States Department of Agriculture. Papers of the Department of Botany and the Herbarium of the University of Michigan No. 417.

² The designations of collections are the accession numbers of the writer.

sp. gave infection on *Koeleria cristata* while *Trisetum spicatum* gave negative results.

Apparently, as suggested by Arthur, *Puccinia monoica* contains several races. These may be designated as follows: sp. f. *Koeleriae* on *Koeleria cristata*; sp. f. *Triseti* on *Trisetum spicatum* (*T. subspicatum*). Another race apparently also is specialized to species of *Stipa*.

***Puccinia conspicua* sp. nov.**

Arthur (1918) described *Aecidium conspicuum* Arth. from aecia on *Dugaldia Hoopesii*. The type was collected by J. C. Arthur and F. D. Kern at Snowball Creek near Pagosa Springs, Colorado, August 6, 1912.

In 1921, aecia (Dug. 1) were received from Mr. Bethel who had collected them May 30, on *Dugaldia Hoopesii* in the type locality for the *Aecidium*. At the time, he noted that *Koeleria cristata* closely associated with the aecia was showing uredinia. The aecia were used to inoculate *Koeleria cristata* resulting in the development of uredinia two weeks later. The rust on *Koeleria cristata* was multiplied by reinoculation and was then used to inoculate *Oryzopsis miliacea*, *Stipa comata*, *S. lepida*, *S. pulchra*, *S. viridula*, and *Koeleria cristata* resulting in the development of uredinia only on *Koeleria cristata*. Reinoculations on this species resulted in the development of a few telia.

In North America two rusts, *Puccinia Stipae* Arth. and *P. Liatridis* Bethel, have been reported on *Koeleria cristata* with aecia on species of the *Carduaceae*. The aecia of *Puccinia Stipae* differ markedly from those on *Dugaldia*. Although the latter are very similar to the aecia of *Puccinia Liatridis*, the uredinia and telia produced by *Aecidium conspicuum* on *Koeleria cristata* differ in several important respects from those of *Puccinia Liatridis*, the urediniospores being narrower and longer and the teliospores much shorter. Apparently this rust on *Koeleria cristata* is undescribed.

The species may be characterized as follows:

Syn. *Aecidium conspicuum* Arth. Bull. Torrey Club 45: 153. 1918. Sydow, Monog. Uredinearum 4: 42. 1924.

Uredinis amphigeniis, demum nudis, elongatis, 0.2-1.0 (2.0) mm. longis, flavo-brunneis; urediniosporis oblongo-ellipsoideis, 14-19 \times 24-38 μ ; tunica

pallide brunnea vel pallide flava, 1.5–2.5 μ crassa, modice et minute echinulata: poris 4–6, obscuris, sparsis.

Teliis amphigeniis, tarde nudis, 0.2–1.0 mm. longis, castaneo-brunneis; teliosporis irregulariter ellipsoideis vel clavatis, 20–28 \times 28–40 μ ; tunica, flavo-brunnea, 1 μ crassa, apice irregulariter rotundatis vel truncatis, incrassatis (5 μ); pedicello brevissimo.

On *Koeleria cristata*, Snowball Creek, Pagosa Springs, Colorado, E. Bethel, June 30, 1921, (type) associated with aecia on *Dugaldia Hoopesii* (A. Gray) Rydb.

PUCCINIA KOELERIAE Arth.

In 1920, two collections of telia of *P. Koeleriae* (15720, 15820) were received from Mr. Bethel who had collected them on *Koeleria cristata* at Pagosa Springs, Colorado, October 18. These were overwintered and were used to inoculate *Berberis canadensis*, *B. Fendleri*, *B. trifoliata*, *Mahonia Aquifolium*, and *M. repens*. Abundant infection was obtained on *Berberis Fendleri*, the others giving negative results. The infection on *Berberis Fendleri* was unusually abundant. Although in most cases the infection was localized and produced a limited mycelium, in some cases apparently very young buds were infected. As the buds developed, the mycelia spread throughout the leaves modifying their form, usually producing a compact rosette with pycnia and aecia developing throughout.

In the spring of 1922, one of the infected plants of the year before produced two short branches with leaves bearing pycnia distributed throughout. Apparently these originated from two of the infected buds of the previous season. Aecia did not develop. This plant was retained in the greenhouse and observed annually for seven years. Each year most of the new branches bore leaves showing pycnia. No aecia were produced after the first year. In the spring of 1928 an attempt was made to stimulate the production of aecia by mixing nectar from the pycnia. This was without result. Probably the two original buds from which the infected branches arose contained haploid mycelia of the same sexual strain.

The aecia (Ber. 6) produced in the spring of 1921 were used to inoculate *Agropyron caninum*, *A. Smithii*, *A. tenerum*, *Aira caespitosa*, *A. flexuosa*, *Arrhenatherum elatius*, *Avena fatua*, *Elymus canadensis*, *E. glaucus*, *E. striatus*, *E. virginicus*, *Holcus*

lanatus, *Hordeum Gussoneanum*, *H. jubatum*, *H. vulgare*, *Hystrix Hystrix*, *Koeleria cristata*, *K. gracilis*, *Melica imperfecta*, *Oryzopsis miliacea*, *Poa palustris*, *P. pratensis*, *Secale cereale*, *Sitanion Hystrix*, *Sphenopholis obtusata*, *Trisetum sesquiflorum*, and *Triticum vulgare*. *Koeleria cristata* and *Trisetum sesquiflorum* were very susceptible producing well developed uredinia and later telia. *Koeleria gracilis* was slightly infected producing small uredinia accompanied by necrosis. The other species showed little or no signs of infection.

Aecia collected by Mr. Bethel on *Berberis Fendleri* (Ber. 10) at Pagosa Springs, Colorado, June 29, 1921, were used to inoculate *Agropyron tenerum*, *A. Smithii*, *Elymus canadensis*, *Sitanion Hystrix*, and *Koeleria cristata* resulting in abundant infection on *Koeleria cristata* and negative results with the others.

Mr. Bethel also collected aecia on *Mahonia (Berberis) Aquifolium* at Pagosa Springs, June 30, 1921. The plants were heavily infected but the aecia were mostly young. Inoculation with this material on *Koeleria cristata* gave only slight infection. Reinoculation with the uredinia thus produced was not successful.

The species *Puccinia Koeleriae* was described by Aruthur (1909) as the result of an inoculation from telia on *Koeleria cristata* which produced aecia on *Mahonia Aquifolium*. The writer (1921) has shown that *Puccinia montanensis* has its aecial stage on *Berberis Fendleri*. The aecia of *P. Koeleriae* and *P. montanensis* and those produced by the cultures just described show no marked differences. The rust of *Koeleria cristata* connected with aecia on *Berberis Fendleri*, however, differs markedly from *Puccinia montanensis* both in morphology and in grass hosts and agrees very well with *P. Koeleriae*, differing principally in slightly thinner-walled paraphyses. The results obtained in these studies strongly suggest that there are two races of *P. Koeleriae*, one having aecia on *Mahonia Aquifolium* and the other with aecia on *Berberis Fendleri*.

The species, *Puccinia Koeleriae*, *P. Arrhenatheri* (Kleb.) Erikss., *P. montanensis*, and *P. glumarum* (Schmidt) Erikss. & Henn., form an interesting series. *Puccinia Koeleriae* has scattered uredinia with abundant paraphyses. *Puccinia Arrhenatheri* resembles *P. Koeleriae* very closely as far as its uredinia and telia

are concerned. The paraphyses of *Puccinia montanensis* are fewer, smaller and thinner walled than those of the two preceding. It, however, differs most markedly in that its uredinia and telia are arranged in more or less definite lines. *Puccinia glumarum* has few or no paraphyses. It resembles *P. montanensis* in the arrangement of its uredinia and telia in lines but differs in color of the urediniospores and size of the teliospores. *Puccinia Koeleriae*, *P. Arrhenatheri*, and *P. montanensis* all produce aecia on species of *Berberis* or *Mahonia*. The relationship indicated above suggests the possibility that the aecial host of *Puccinia glumarum* may also be some species of *Berberis* or *Mahonia*.

PUCCINIA INTERVENIENS Bethel.

Telia (18520) collected by Mr. Bethel on *Stipa pulchra*, Mill Valley, California, Sept. 24, 1920, were used to inoculate *Aster multiflorus*, *Sidalcea candida* and *Solidago rigida* in the spring of 1921. Pycnia followed by aecia were produced only on *Sidalcea candida*.

Another collection of telia (18620) obtained by Mrs. Clemens on a species of *Stipa* at Carmel, California, March 30, 1921, was received from Mr. Bethel. This was used to inoculate *Sidalcea candida* resulting in the production of pycnia and aecia. The aecia (Sid. 2) from this infection were used to inoculate *Oryzopsis miliacea*, *Stipa minor*, *S. pulchra*, *S. viridula*, and *Stipa* sp. *Oryzopsis miliacea*, *Stipa pulchra* and *Stipa* sp. were infected showing telia with a few urediniospores.

In September 1921 a collection of telia (7221) was received from Mr. Bethel. This consisted of a mixture of *Puccinia interveniens* and *P. substerilis* on *Stipa Lettermannii* collected Sept. 5, 1921, at Sulphur Springs, Colorado. The teliospores of *P. interveniens* were found germinable and were sown on *Sidalcea candida* resulting in the development of pycnia and aecia.

These results support the conclusions reached by Mr. Bethel both through his field observations and as the result of a number of cultures (Blasdale 1919).

PUCCINIA MICRANTHA D. Griffiths.

Overwintered telia (19220) collected by Mr. Bethel, April 14, 1921, in the Garden of the Gods, Colorado, on *Oryzopsis micrantha*

(Trin. & Rupr.) Thurb., were used to inoculate *Aster multiflorus*, *Ribes aureum*, *R. Cynosbati*, *R. floridum*, *R. nigrum*, *R. oxacantha*, *Sidalcea candida*, and *Solidago rigida*. Pycnia developed on *Ribes oxacantha* and pycnia and aecia on *R. aureum*. The rest gave negative results. These results agree with Mr. Bethel's field observations which indicated a connection with aecia on *Ribes*.

PUCCINIA ANDROPOGONIS Schw.

Telia (12020) collected by H. S. Jackson at Shadeland, Indiana, Sept. 15, 1920, were overwintered and sown in April 1921 on *Linaria canadensis*, *Oxalis corniculata*, *Pentstemon hirsutus*, *P. secundiflorus*, and *Viola cucullata*. Pycnia and aecia developed only on *Pentstemon hirsutus*.

Telia (12320) collected by the writer on *Andropogon* sp. at Shadeland, Indiana, Sept. 15, 1920, were sown in April 1921 on *Linaria canadensis*, *Oxalis corniculata*, *Pentstemon hirsutus*, *Polygala Senega*, and *Viola cucullata* with development of pycnia only on *Pentstemon hirsutus*.

Telia (13920) collected by J. J. Davis on *Andropogon scoparius* at Muscoda, Wisconsin, Sept. 4, 1920, were used in April 1921 to inoculate *Linaria canadensis*, *Oxalis corniculata*, *Pentstemon hirsutus*, and *Viola cucullata* with the production of pycnia and aecia only on *Pentstemon hirsutus*.

Overwintered telia (31319) collected on *Andropogon scoparius* by H. D. House at Albany, New York, April 1920, were used to inoculate *Chelone glabra* and *Pentstemon secundiflorus*. A few pycnia developed on *Pentstemon secundiflorus*. Abundant pycnia and aecia developed on *Chelone glabra*.

Telia collected by the writer on *Andropogon scoparius*, at Ann Arbor, Michigan, Oct. 23, 1919, were sown on *Polygala Senega* in April 1920 with the production of abundant pycnia and aecia. Aecia collected by the writer on *Polygala Senega* at Ann Arbor, Michigan, in May 1932 were used to inoculate *Andropogon scoparius* with the production of uredinia and telia.

These results support those obtained by Arthur (1900, 1904, 1906, 1907, 1912, 1915), Long (1912, 1914) and Davis (1926, 1929, 1931). *Puccinia Andropogonis* produces aecia on *Amphicarpa monoica*, *Chelone glabra*, *Camandra umbellata*, *Lupinus perennis*, *Pentstemon hirsutus*, *Polygala Senega*, and *Zanthoxylum*

americanum. The rust of *Andropogon* connected by Long (1912) with aecia on *Oxalis* and placed by Arthur and Fromme (1920) in *Puccinia Sorghi* also apparently belongs here, thus adding species of *Oxalis* as aecial hosts for *Puccinia Andropogonis*.

Arthur and Fromme (1920) state that *Puccinia Andropogonis* contains two races separable by the families of the aecial hosts, Santalaceae and Scrophulariaceae as well as by slight morphological differences. These conclusions were based on the results of cultures in which aecia were produced on *Comandra unbellata* but not on *Pentstemon hirsutus* and *P. alpinus* by one race while aecia were produced on *Pentstemon alpinus* but not on *Comandra unbellata* by the other. The results of the studies reported here would indicate that the race having aecia on *Pentstemon* is also distinct from the rust going to *Oxalis* and *Polygala*. The cultures of Davis indicate that the rust with aecia on *Polygala Senega* is a separate race from that with aecia on *Amphicarpa monoica*. It is very probable that races occur specialized to *Amphicarpa*, *Polygala*, *Lupinus*, *Zanthoxylum*, *Oxalis*, *Comandra* and *Pentstemon* respectively. *Chelone glabra* may also be a host for the race with aecia on *Pentstemon*.

Puccinia ELLISIANA Thüm.

Telia (125) collected by the writer Sept. 25, 1925, at Lafayette, Indiana, on *Andropogon* species were sown in May 1926 on *Baptisia australis*, *Oxalis corniculata*, *O. europea*, *O. stricta*, *Pentstemon gentianoides*, *P. laevigatus*, and *Viola papilionacea*. Pycnia and aecia were produced in abundance on *Viola papilionacea*, the rest giving negative results.

Telia (326) collected by the writer at Lafayette, Indiana, in 1926 were sown in April 1927 on *Baptisia australis*, *Falcata comosa*, and *Viola papilionacea* resulting in abundant aecia on *V. papilionacea*. Another collection (426) from Lafayette, Indiana, was used to inoculate *Oxalis corniculata*, *O. europea*, *O. stricta*, *Polygala Senega*, *Falcata comosa*, *Baptisia australis*, *Viola affinis*,³ *V. chinensis*, *V. glabella californica*, *V. incognita*, *V. nephrophylla*, *V. pallida*, *V. papilionacea*, *V. pinnata*, *V. sagittata*, *V. septentrionalis*, *V. sororia*, and *V. tricolor* (Giant White pansy). Pycnia

³ Seeds of a number of the species of *Viola* were kindly supplied by Mr. A. Gershoy of the University of Vermont.

and aecia developed very abundantly on *Viola nephrophylla*, *V. papilionacea*, *V. septentrionalis*, and *V. sororia*. A moderate development occurred on *Viola affinis* and *V. tricolor*. A few aecia were produced on *Viola pinnata*. Only pycnia occurred on *Viola chinensis*, *V. glabella californica*, *V. incognita*, and *V. sagittata*. No signs of infection were noted for *Viola pallida*.

Puccinia Ellisiana is very closely related to *P. Andropogonis*. It is separated by its specialization to species of *Viola* for its aecial hosts and by less pronounced morphological differences.

Long (1912) obtained pycnia and aecia on *Viola fimbriatula*, *V. hirsutula*, *V. papilionacea*, and *V. sagittata* from telia collected on *Andropogon virginicus* in Virginia. *Viola cucullata*, *V. pedata*, and *V. primulifolia* gave negative results.

Arthur (1915) obtained aecia on *Viola cucullata* and *V. Nuttallii* from telia collected in North Dakota. *Viola primulifolia*, *Laciniaria punctata*, and *Lithospermum angustifolium* gave negative results.

It is evident that the results obtained with *Viola cucullata* and *V. sagittata* are not in agreement. Arthur obtained aecia on *Viola cucullata* while Long had negative results. Long found *Viola sagittata* a favorable host while only pycnia were obtained in the studies reported here. This indicates either that several races occur or that there are strains of these species of violets differing in their reactions.

PUCCINIA WINDSORIAE Schw.

Telia (19520) collected by the writer on *Tridens flavus* (L.) Hitchc. Aug. 23, 1920, at Battle Ground, Indiana, were overwintered and sown in April 1921 on *Dirca palustris* and *Ptelea trifoliata* with the production of pycnia and aecia on *Ptelea trifoliata*. Arthur (1900, 1903, 1905, 1916) proved this connection with rust from Indiana and Texas. *He was not able to infect *Dirca palustris*, *Zanthoxylum americanum*, or *Ambrosia trifida*.

PUCCINIA POLYGONI-AMPHIBII Pers.

The rust of *Polygonum virginianum* is of special interest since it is distinguished from that on other species of *Polygonum* by having subequatorial germ pores in the urediniospores instead of superequatorial pores. It is of importance, therefore, to deter-

mine the aecial host of the rust of *Polygonum virginianum* in order to throw light on its relationship.

Telia of this rust collected on *Polygonum virginianum*, by L. E. Wehmeyer at Ann Arbor, Michigan, were overwintered and sown in May 1932 on *Geranium maculatum* resulting in abundant production of pycnia and aecia. The aecia thus obtained were used to inoculate *Polygonum virginianum* resulting in the production of abundant uredinia and later telia as the result of reinoculations. The urediniospores of the original collection as well as those produced from aecia were found to have subequatorial or sometimes approximately equatorial germ pores.

The studies of Tranzschel (1903, 1905), Arthur (1905, 1906, 1907), Klebahn (1905), Bubak (1906), Treboux (1912a, b), Jacob (1916) have shown that *Puccinia Polygoni-amphibii* contains a number of races which may be distinguished by specialization to both aecial and telial hosts. *Geranium maculatum*, the favorable aecial host for the North American rust gave negative results in all the European studies. The results of the latter investigations also indicate that there are a number of races in Europe which may be distinguished by the reactions of such species as *Geranium pratense*, *G. pusillum*, *G. phaeum*, and also by species of *Polygonum*. Although the rusts from *Polygonum emersum* and *P. virginianum* in North America both produce aecia on *Geranium maculatum*, they probably also are specialized to different species of *Polygonum* and should at least be considered different races.

UROMYCES ACUMINATUS Arth.

Telia (13620) collected by H. S. Jackson, October 5, 1920, at Riverside, Indiana, on *Spartina Michauxiana* were sown in March 1921 on *Polemonium reptans* and *Phlox divaricata* resulting in abundant pycnia and aecia on *Polemonium reptans* and a few pycnia on one plant of *Phlox*. Telia (14420) collected by H. S. Jackson, October 14, 1920, at Shelby, Indiana, on *Spartina Michauxiana* were sown in March 1921 on *Polemonium reptans* and *Phlox divaricata* resulting in the production of pycnia and aecia only on *Phlox divaricata*.

Arthur (1906, 1908) obtained aecia on *Steironema ciliatum* from telia on *Spartina Michauxiana* collected in Nebraska. Negative

results were obtained with *Lysimachia quadrifolia*, *Polemonium reptans*, *Polygala Senega*, *Cassia Chamaecrista*, *Psoralea Onobrychis*, *Rudbeckia laciniata*, *Ambrosia artemisiaefolia*, *Thalictrum dioicum*, and *Viola papilionacea*. Collections (Arthur 1912a) from North Dakota and Colorado produced aecia on *Polemonium reptans* while *Steironema ciliatum*, *Hydrophyllum capitatum* and *Phlox divaricata* gave negative results. A collection (Arthur 1915) from Colorado produced aecia on *Collomia linearis*, while *Steironema ciliatum* and *S. lanceolatum* gave negative results.

It is evident, therefore, that *Uromyces acuminatus* contains a number of races distinguished by their specialization to species of *Polemonium*, *Phlox*, *Steironema* and probably *Collomia*.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICHIGAN

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MYCOLOGICAL NOTES FOR 1930-32¹

L. O. OVERHOLTS

(WITH PLATES 45-47)

PHYCOMYCETES

1. PERONOSPORA FICARIAE Tul.

On living leaves of *Ranunculus recurvatus*. Lock Haven, Pennsylvania. (No. 14319.)

Conidia broadly ellipsoid, hyaline, $22-30 \times 16-24 \mu$.

2. PERONOSPORA HYOSCYAMI DeBary.

On living leaves of *Nicotiana Tabacum*. Lancaster County, Pennsylvania. (No. 14602.)

Conidia broadly ellipsoid to nearly globose, smooth, hyaline, $13-17 \times 12-14 \mu$. Not widely reported in the United States until very recently.

3. SYNCHYTRIUM PLANTAGINEUM Sacc. & Speg.

On *Plantago virginica*. Pilot Knob, Missouri. May 21, 1927. (No. 12725.)

This species was originally described from Spegazzini's collections in South America. Dr. Dearness has kindly communicated to me a small portion of a collection reported in the Tracy and Earle list of Mississippi fungi in 1895, on *Plantago lanceolata*. This is probably the only record of the occurrence of the species in this country.

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This paper is a continuation of a series, all under a similar title, that was begun in 1919, and published either in MYCOLOGIA or in the Bulletin of the Torrey Botanical Club. I am indebted to the following persons for aid in identification of some of the species: Miss Edith K. Cash and Mr. W. W. Diehl of the Office of Mycology, Washington, D. C., and Dr. J. Dearness, London, Ontario.

4. *SYNCHYTRIUM STELLARIAE* Fuckel.

On *Cerastium vulgatum*. Mine Lamotte, Missouri. May 14, 1926. (No. 12723.)

Species of *Cerastium* are listed in the European literature as hosts for both *Synchytrium aureum* and *S. Stellariae* but that host has received little mention in this country. The Seymour host index lists the latter species on *Stellaria media* but not on *Cerastium*. Dr. Davis lists no fungi of this group on either host, nor have we found it in any other American list. In this collection it occurred in great abundance on both leaves and stems of *C. vulgatum*. The species is not in Maneval's list of Missouri fungi.

ASCOMYCETES

5. *CRYPTODISCUS ANGULOSUS* Karst.

On dead branches of *Salix*. Potter County, Pennsylvania. (No. 14495.) FIGS. 1, 2.

Apothecia gregarious, circular to somewhat angular or slightly elongate, long covered by the epidermis, finally exposing the dark olivaceous disk bordered by the irregularly torn host tissue, the disk $\frac{1}{3}$ - $\frac{1}{2}$ mm. diameter; asci ellipsoid when mature, 8-spored, $35-55 \times 11-16 \mu$; spores cylindric or slightly curved, smooth, hyaline, 4-celled, $14-24 \times 3-3.5 \mu$; paraphyses linear, apparently branched at the tip to form an epithecium.

Dr. Dearness writes that *Propolidium fuscocinereum* Ellis & Ev. was indicated as a synonym by Rehm in 1912.

6. *DERMATEA PRUNASTRI* (Pers.) Fries.

On dead limbs of wild species of *Prunus*. Pennsylvania. (No. 15121.) FIG. 7.

At first erumpent through the bark as spine-like or cylindrico-conic stromata, hard and brittle when dry, projecting for about 1 mm., with total length of 1400-1600 μ , 650-850 μ diameter at the base, in section short-columnar and sometimes abruptly constricted at the base; macroconidia hyaline, curved, pointed at the ends, 1-celled, $11-15 \times 2.5-3 \mu$, produced in a single internal pycnidial cavity in the tip of the stroma; microconidia hyaline, 1-celled, cylindric, $6-7 \times 1 \mu$, produced in superficial spermatogonia on the exterior of the apex of the stroma; apothecia superficial, singly or

grouped on the apex of the stroma; asci clavate-cylindric, $60-80 \times 8.5-10 \mu$, 8-spored; ascospores ovoid-elliptic to elongate, hyaline or nearly so, 1-celled, $7-10 \times 3-4 \mu$.

Sphaeronema spurium (Fries) Sacc. is said to be the name of the macroconidial stage.

My specimens are evidently not quite mature, and that may account for the somewhat smaller measurements of the ascospores.

7. *LACHNELLULA CHRYSOPHTHALMA* (Pers.) Karst.

On dead twigs of *Pinus Banksiana*. Iroquois Falls, Ontario. (No. 15125.)

With aspect entirely of a *Dasyscypha*; apothecia attached by a narrowed base, gregarious, singly or clustered in twos or threes, 1-2 mm. diameter when fresh, yellow or golden when wet, externally white hairy when dry, the hymenium golden but drying pale orange, the margin strongly incurved; asci cylindric, narrowed at the base, $50-75 \times 5-7 \mu$, 8-spored; spores globose, uniseriate, smooth, hyaline, $4-4.5 \mu$ diameter; paraphyses exceeding the asci, not enlarged at the apex, simple, 2μ diameter.

The species seems to be unreported in the American literature dealing with the fungous flora of eastern North America, though reported by Seaver (*Mycologia* 3: 64. 1911) as common in the Rocky Mountains.

8. *MICROSPHAERA RUSSELLII* Clinton.

On living leaves of *Oxalis*. Pennsylvania. (No. 15003.)

One of the more uncommon species of powdery mildews. The spores are considerably smaller than recorded by Salmon, being $9-16 \times 7-9 \mu$, but may not be mature.

9. *PHYSALOSPORA RHODODENDRI* (DeNot.) Rehm.

On living leaves of *Rhododendron maximum*. Lake Harmony, Carbon County, Pennsylvania. Sept. 4, 1921. (No. 12012.)
FIG. 10.

The following notes were made from this collection: Spots small and circular, sometimes confluent and somewhat irregular, 2-7 mm. diameter, dirty brown with a somewhat darker raised margin, the center sometimes gray; perithecia epiphyllous, sparse, often invisible to the unaided eye, rather deeply imbedded in the meso-

phyll of the leaf, with ostiole definitely protruding to form a small black papilla, rather elongate and sac-like, about $270 \times 150 \mu$; asci large, saccate with ends obtusely pointed, $90-120 \times 30-36 \mu$; spores biserial, 8 per ascus, ellipsoid, one-celled, hyaline or slightly yellowish, granular, thick-walled, $25-42 \times 14-15 \mu$; paraphyses none.

10. *TYMPANIS SALIGNA* Tode.

On dead twigs of *Salix*. Cross Fork, Potter County, Pennsylvania. May 28, 1932. (No. 14314.)

Asci $120-190 \times 15-20 \mu$, with countless bacilliform spores, $3-3.5 \times 0.75-1 \mu$. Paraphyses linear, not enlarged at the tips, simple, 1.5μ diameter. Apothecia $\frac{1}{3}-\frac{1}{4}$ mm. diameter.

In all of these points the collection departs from the descriptions which call for smaller asci, paraphyses enlarged at the tips to 5μ , branched; apothecia larger ($0.5-1.5$ mm.).

Other species of *Tympanis* not previously reported in these notes are:

Tympanis acerina Peck. On dead *Acer rubrum*; Pennsylvania and New Hampshire. (No. 11264, 12185.) Seaver (Mycologia 25: 144. 1933) records this name in synonymy under *Pezicula acericola*.

Tympanis alnea (Pers.) Fries. On dead *Alnus*; Pennsylvania. (No. 10960.)

Tympanis Pinastri Tul. On dead *Pinus Strobus*; Pennsylvania. (No. 14325, 14981.) On *Cronartium ribicola* canker on *Pinus Strobus*; New York. (No. 9408.) On *Abies balsamea*; Pennsylvania and New Hampshire. (Nos. 8609, 5037.)

11. *VALSA ETHERIALIS* Ellis & Ev.

On dead branches of *Acer rubrum*. Huntingdon County, Pennsylvania. March 1, 1930. (No. 12178.)

While the original description is extremely meager, giving only the size of the perithecia, asci, and spores, the agreement of my material on all these points, and the great differences when compared with other species described on the same host, makes it quite probable that my material is correctly referred. Asci measure $15-24 \times 4-6 \mu$, 8-spored; spores allantoid, hyaline, $5-6 \times 1 \mu$.

FUNGI IMPERFECTI

12. *CERCOSPORA ELONGATA* Peck.

On leaves of *Dipsacus sylvestris*. Greenbush, Ohio, 1926, and Huntingdon County, Pennsylvania, 1932. (No. 12991, 14599.)

The species rarely appears in local lists of fungi. My specimens could hardly agree better with Peck's description. Spores $60-120 \times 4-4.5 \mu$, with a few indistinct septa. The fungus inhabits definite ashen-brown spots and fruits on the upper surface of the leaves.

13. *DENDRYPHIUM TORULOIDES* (Fres.) Sacc.

On dead stems of *Solanum dulcamarum*. Pennsylvania. (No. 14927.) FIG. 8.

Forming a broad strigose mat of blackish hairs (conidiophores) on surface of stem, these erect, straight, septate, $200-400 \times 9-12 \mu$, branched somewhat at the apex with short branches that cut off spores, presumably in chains; conidia elongate, with rounded ends, 2-5-septate, dark brown, slightly constricted at the septa, $15-28 \times 6-7 \mu$.

Species of this genus are rarely collected.

14. *DINEMASPORIUM PATELLUM* Cooke & Ellis.

On dead stems of *Phytolacca decandra*. Center County, Pennsylvania. (No. 14232.) FIG. 3.

With aspect of a setose *Lachnea* in every respect under a lens, 1-2 mm. diameter, dark brown with black hairs; conidia elongate, straight or crescent-shaped, hyaline, 1-celled or appearing 2-celled at times, both ends inconspicuously appendaged with a short hyaline bristle, the spore body $16-24 \times 1.5-2 \mu$.

D. Pezicula Berk. & Curt. may not be distinct.

15. *FUSICOCCUM PERSICAE* Ellis & Ev.

Little has been written concerning this fungus and the possibility of its parasitism on *Prunus Persica*. At least it is not generally recognized as a menace to the peach tree. The species was originally described from Louisiana. In 1922 a specimen came into my hands from J. C. Dunegan, at Fort Valley, Georgia. In February 1931, it was collected in Adams County, Pennsylvania, by R. S. Kirby, on peach trees that had been obtained from the

south. The fungus may not be parasitic but the evidence could be taken to indicate that it is the cause of the death of the twigs, producing an injury similar to that usually associated with *Valsa leucostoma*. The spores measure $20-24 \times 4-6 \mu$, and therefore over-run slightly the measurements given in the original description.

16. *ISARIA UMBRINA* (Pers.) Fries.

Forming pulverulent, pale cinnamon, clavarioid coremia about 1 mm. high, over the surface of *Hypoxylon* stromata. Spores pale brown, ovoid or elliptic, $3-4.5 \times 2.5-3 \mu$.

Saccardo gives *I. acariforme* Fries as a synonym, under which name apparently this species was distributed by Ellis in N. A. Fungi no. 1328, and by Ellis & Everhart in Fungi Columb. no. 2036.

In my specimens the coremia are not dichotomously branched—in fact are usually simple—in contrast to the figure and description given in Rabenhorst's Kryptogamenflora, where it is described in two places, once under the above name and once as *Trichosporium umbrinum* (Pers.) Lindau. Four Pennsylvania collections have been incorporated into the herbarium.

17. *MACROPHOMA CORNINA* (Peck) Sacc.

On dead twigs of *Cornus Amomum*. Huntingdon County, Pennsylvania. (No. 13795.)

Spores yellowish or smoky, smooth, short-cylindric or oblong, one-celled, content granular, $22-32 \times 9-14 \mu$; pycnidia 200-280 μ diameter.

Perhaps better placed in *Sphaeropsis* than in *Macrophoma*. Reported on two other species of *Cornus* in the Seymour Index.

18. *PHOMA SPERMIOIDES* Dearness.

On dead stems of *Thalictrum*. Pennsylvania. (No. 14928.)
FIG. 9.

Described first in Mycologia 16: 160. 1924, from New York. On some of the stems all of the pycnidia are collapsed at the summit so as to appear disk-shaped and simulating a leptostromaceous pycnidium. They are sub-epidermal in origin but by weathering away of the fibrous outer cortex tissue finally may appear superficial.

19. RAMULARIA IMPATIENTIS Peck.

On leaves of *Impatiens pallida*. Clinton County, Pennsylvania. 1929. (No. 12138.)

The collection yielded the following notes:

Spots circular or irregular, 2–13 mm. diameter, at first deep purplish-red all over, the center soon rusty-brown to brown and in the largest spots the red-purple margin completely disappearing; conidiophores short, fascicled, epiphyllous or amphigenous, forming a minute scurfiness over the surface of the spot; conidia cylindric or short-cylindric, hyaline, 1-celled, $10\text{--}21 \times 3.5\text{--}5 \mu$.

20. SEPTORIA CALLISTEPHI Gloyer.

Early in September of 1930 Doctor G. L. Zundel brought in specimens of Chinese aster heavily infected with a *Septoria*. The specimens were collected in a nursery near Reading, Pa., and the loss in a ten-acre tract of the asters was said to be almost entire. The major part of the leaf tissue was dead and the plants were reported as dying rapidly. Examination showed the parasite to be near if not identical with *Septoria astericola* Ellis & Ev. Specimens sent to Dr. Dearness were identified as probably *S. Callistephi*, and the meager data given by Gloyer (Phytopath. 11: 50. 1921) seems to agree. It is not improbable that these names are to be regarded as synonyms. Certainly if this collection be *S. Callistephi* there is little to separate it from the first-named species. The pycnidia in this collection measure $90\text{--}100 \mu$ diameter and the spores are slightly curved, hyaline, multi-guttulate, the number of cells indistinct, and measure $25\text{--}45 \times 1.5 \mu$. (No. 12403.)

21. SEPTORIA CERASTII Rob. & Desm.

On leaves of *Cerastium vulgatum*. Mine Lamotte, Missouri. 1927. (No. 12724.)

Probably this fungus is not uncommon on *Cerastium* and perhaps other Caryophyllaceous hosts. It is listed by both Davis from Wisconsin and by Schwarze from New Jersey. It is a very inconspicuous fungus and seems to cause no necrosis of host tissues, but the pycnidia appear crowded or gregarious on slightly paler areas on the upper surfaces of the leaves. They are globose or slightly compressed-globose, thin-walled, and $60\text{--}100 \mu$ diameter.

The spores are linear, straight or nearly so, and measure $26-40 \times 1 \mu$. The species is not found in Maneval's list of Missouri Fungi.

22. *Septoria Hypoxis* sp. nov.

Spots irregular, following the veins or along the midrib, limited by the larger veins, elongated, blackish and water-soaked; pycnidia amphigenous, blackish, $100-140 \times 85-100 \mu$, with a definite blackish wall, sub-epidermal; spores linear, nearly straight or slightly curved, hyaline, apparently 1-celled, $25-40 \times 1-1.5 \mu$.

On living leaves of *Hypoxis hirsuta*. Type collected in Shingle-town Gap, Center County, Pennsylvania. June 18, 1932. (No. 14357.) FIG. 5.

I find no record of a *Septoria* on *Hypoxis*. *Cylindrosporium guttatum* Winter is described as with spores $53-70 \times 2 \mu$. My collection is definitely a *Septoria*.

23. *SEPTORIA PODOPHYLLINA* Peck.

On leaves of *Podophyllum peltatum*. St. Francois River, southern Missouri. 1927. The species is not in Maneval's list, and appears to be a much less common fungus than the *Phyllosticta* on the same host. Two collections are also at hand from Pennsylvania. Spores mostly 3-septate, straight or slightly curved, $24-50 \times 1.5-3 \mu$.

24. *SEPTORIA SIBIRICA* Thüm.

This little known species was discovered in a student collection on plant diseases made in central Pennsylvania in 1921, on *Ribes vulgare*. The fruiting body in this case is an acervulus or a very imperfectly developed pycnidium as in the case of specimens collected by J. J. Davis and described by him as *Cylindrosporium Ribis* (Trans. Wisc. Acad. Sci. 16: 759. 1909). Later he admitted that his species was referable, in its better developed forms, to *Septoria sibirica* and he distributed specimens under that name. Fungi Columbiani No. 4625 distributed as *C. Ribis* belongs here.

The species seems to differ from *Septoria Ribis* Desm. in the smaller size of the fruiting structures and in the considerably longer spores. My spore measurements from the Pennsylvania collection are $21-75 \times 2 \mu$, while the fruiting bodies measure but $30-45 \mu$ diameter.

25. SEPTORIA SPECULARIAE Berk. & Curt.

On leaves of *Specularia perfoliata*. Mine Lamotte, Missouri. 1927. Olivet, Armstrong County, Pennsylvania. 1931. (No. 12975, 13885.)

The fungus fruits abundantly on the under surface of the dying lower leaves, not producing definite spots. The Pennsylvania collection showed pycnidia also on the stem and calyx. The spore characters of the two collections are in close agreement, 3-septate, $24-50 \times 2-2.5 \mu$. Previously reported from both Missouri and Pennsylvania and found in several check lists in this country.

26. SEPTORIA VIRIDITINGENS Curt.

On living leaves of *Allium tricoccum*. Potter County, Pennsylvania. (No. 14993.)

A very characteristic species, the diseased areas with a greenish tinge, later whitening at the center; pycnidia numerous, brown, $90-105 \mu$ diameter; spores straight or slightly curved, $25-50 \times 1-1.5 \mu$, several septate, hyaline. *S. alliorum* West. is usually listed as a synonym.

BASIDIOMYCETES

27. ALEURODISCUS FARLOWII Burt.

On dead branches of *Tsuga canadensis*; Pennsylvania. (No. 14233, 14512.)

Burt records this species only from New Hampshire and New York.

Other species of *Aleurodiscus* collected or received in recent years are:

Aleurodiscus accrinus (Pers.) Höhn. & Lit. On the bark of living trees of *Acer*, *Carya*, *Fraxinus*, and *Quercus*. New Hampshire, Vermont, Pennsylvania, Florida, and Missouri. A common species.

Aleurodiscus amorphus (Pers.) Rab. On dead *Abies balsamea*; Ontario, New Hampshire, New York, Idaho, and Manitoba. On *Picea* twigs; Colorado.

Aleurodiscus candidus (Schw.) Burt. On the bark of living trees of *Carya*, *Fraxinus*, and *Quercus*. Pennsylvania, Ohio, and Missouri. A common species.

Aleurodiscus cerussatus (Bres.) Höhn. & Lit. Manitoba.

Aleurodiscus nivosus (Berk. & Curt.) Höhn. & Lit. On bark of living *Juniperus*. Massachusetts, Pennsylvania, Georgia, Ohio, and Indiana. A common species.

Aleurodiscus Oakesii (Berk. & Curt.) Cooke. On bark of living trees of *Carya*, *Ostrya*, and *Quercus*. Pennsylvania and Missouri. A common species.

Aleurodiscus penicillatus Burt. On *Pseudotsuga taxifolia*. Oregon.

28. CORTICIUM SULPHUREUM Fries.

On rotten *Quercus* log. Pennsylvania. (No. 14231.) FIG. 4.

This collection adds a fifth state to those reported by Burt. It is a rare species, tender and hypochnoid in structure, at first mustard-yellow with a few sulphur yellow mycelial cords, the hymenium whitening at maturity, and in this character separable from *C. bicolor* Peck. Spores $3-3.5 \times 2-3 \mu$, broadly ellipsoid, smooth, hyaline.

29. NYCTALIS ASTEROPHORA Fries.

On old decaying pileus of *Russula*. Pennsylvania. (No. 14607.)

In my last series of these notes I recorded the finding of *N. parasitica* (Bull.) Fries, probably for the first time in America. The past season both of these species were brought in from the same locality near State College on the same day. The entire context of *N. asterophora* is transformed into a powdery mass of warted chlamydospores. I secured photos of both collections and they are reproduced herewith. FIGS. 11, 15.

30. PANUS OPERCULATUS Berk. & Curt.

On dead *Alnus* and *Betula*. Ontario and Pennsylvania. (No. 15025, 13878.) FIG. 13.

Sporophore inversely cupulate or pezizoid and affixed by a short dorsal stalk or tubercle or laterally sessile, tough, reviving when moistened, more or less fox-color or rufous when wet, drying grayish or whitish, 3-6 mm. long, 3-10 mm. broad, covered with a short white pubescence that is more apparent on drying; margin incurved; context very thin, tough, in section showing 3 layers,

a superficial tomentose layer, an underlying narrow cuticular layer, and the broader context layer, none of these gelatinized; gills radiating from a lateral point, reddish, very narrow, medium close; spores allantoid, smooth, hyaline, $3.5-4 \times 1-1.5 \mu$; cystidia none.

Older descriptions mention a fugacious veil over the gills of young specimens. My material includes young specimens but none show such an organ. The species is rare but probably widely distributed in eastern Canada and the Appalachian region.

31. *PSATHYRA ECHINATA* (Fries) comb. nov.

On waste heap in woods. State College, Pennsylvania. (No. 14897.) FIG. 14.

A well-marked species of small size, with umber-brown, dry, minutely granulose-warted pileus, free and deep-red gills, and a well developed veil that soon breaks, leaving fragments only on the margin of the pileus. Its affinities are much in doubt. It has been placed in *Agaricus* (*Psalliota*), *Pholiota*, and *Inocybe*, but fits well in none of these genera. The spores in mass are smoky-brown with a distinct red tinge. Possibly *Hypholoma vinosum* Kauffman is the same plant, but his plants grew on wood and are said to have adnate-seceding gills. In Europe it is said to grow in greenhouses, and Kauffman describes plants under the name *Psalliota echinata* from such a habitat. My plants were collected in a woodlot adjoining the campus, where refuse from the greenhouses is dumped. Ricken's illustration (*pl. 31, fig. 6*) as *Inocybe*, represents our plant fairly well.

32. *STEREUM PINI* Fries.

On dead twigs of sapling *Pinus Strobus*. Several collections from Pennsylvania and one from Quebec. FIG. 12.

Burt records this species only from Maine and New Hampshire. Although long unrecognized, it has proved to be common in Pennsylvania on branches of white pine killed by the drought in the last few years. Burt's description is ample but his illustrations are not adequate.

33. *TULASNELLA* IN PENNSYLVANIA

Three species of *Tulasnella* have been incorporated into my herbarium in the last few years.

T. Eichleriana Bres. proves to be rather common, five collections having been entered to date, all from Pennsylvania. Wood of *Populus*, *Betula*, and *Quercus* represents the substrates. The color is gray to smoky olivaceous or with a pinkish tinge, and the aspect is that of a pale thin *Corticium* or *Hypochnus*. Because of the small size of basidia and epibasidia it is a critical species with which to work. See notes by Martin on species of this genus in Iowa (Univ. Iowa Stud. Nat. Hist. 13⁵: 4-9. 1931).

T. fusco-violacea Bres. I have a single collection from New Hampshire on bark of *Abies balsamea*. This species resembles *Corticium vagum* but is less hypochnoid, and has cylindric spores $7-13 \times 3-4 \mu$.

T. violea (Quél.) Bour. & Galz. Five collections are in my herbarium, all from Pennsylvania, on *Acer*, *Carya*, *Fagus*, and *Nyssa*. This is an easy species to study since the basidia, epibasidia, and spores are large enough to be made out satisfactorily.

34. VELUTICEPS FUSCA Humphrey & Long.

Collected on charred wood in the Black Hills of South Dakota, Aug. 7, 1929, by Seaver, Henderson, and Shope. This extends the range of this little known species, it having previously been reported only from Arizona, New Mexico, and Washington. Superficial examination would class the species as a member of the Hydnaceae because of the fascicles of protruding hyphae over the hymenium. But these fascicles are sterile, and therefore the same type of emergences as cystidia, setae, and hyphal pegs. While described as composed of brown hyphae as in other species of the genus, the hyphae that make up these fascicles are brown only when seen in mass, the isolated individuals appearing hyaline. (No. 12117.)

STATE COLLEGE, PENNA.

EXPLANATION OF PLATES

PLATE 45

1. *Cryptodiscus angulosus*. Section through apothecium. $\times 125$. (No. 14495.)
2. *Cryptodiscus angulosus*. Ascus with spores. $\times 800$. Spores $\times 1400$. (No. 14495.)
3. *Dinemasporium patellum*. Section through fruiting body. $\times 175$. Spores $\times 290$. (No. 14232.)

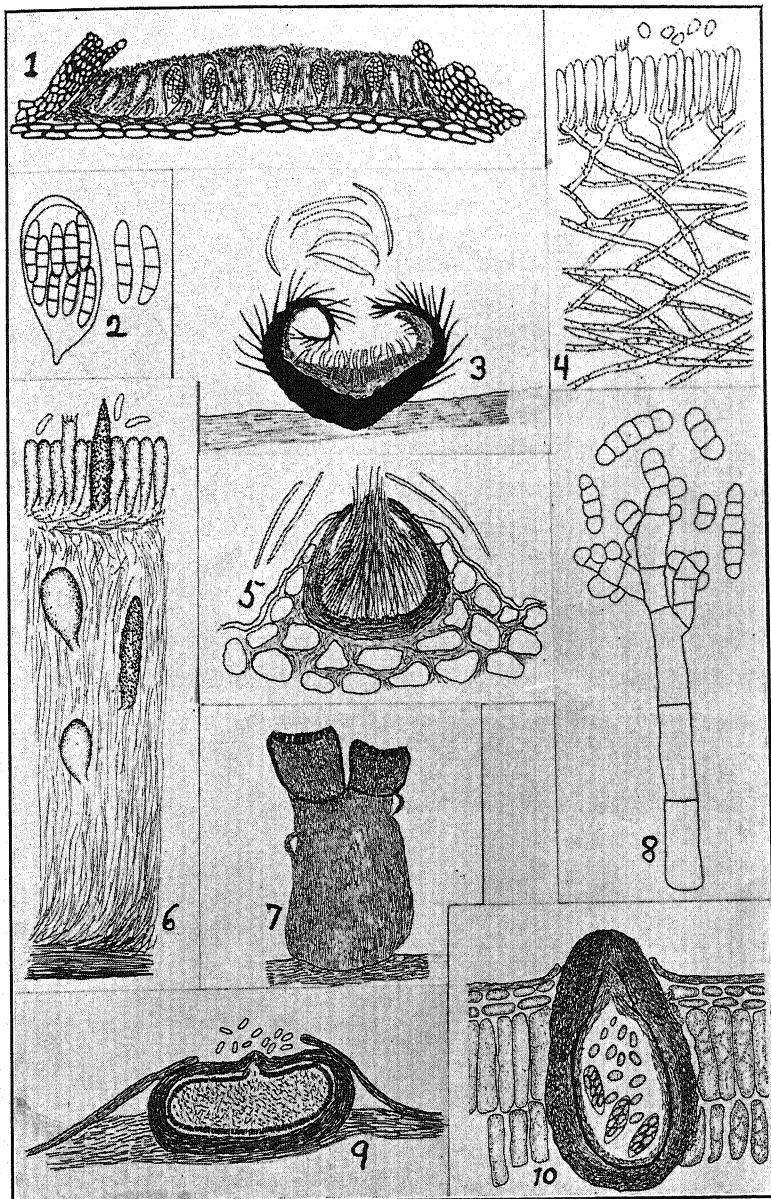
4. *Corticium sulphureum*. Section through sporophore. $\times 200$. Spores $\times 700$. (No. 14231.)
5. *Septoria Hypoxi*. Section through pycnidium. $\times 180$. Spores $\times 500$. (No. 14357.)
6. *Stereum Pini*. Section through sporophore. $\times 370$. (No. —.)
7. *Dermatea Prunastri*. Vertical section of stroma bearing apothecia. $\times 240$. (No. 14458.)
8. *Dendryphium toruloides*. Conidiophore and conidia. $\times 450$. (No. 14927.)
9. *Phoma spermoides*. Section through pycnidium. $\times 100$. Conidia $\times 660$. (No. 14928.)
10. *Physalospora Rhododendri*. Section through leaf bearing a perithecium. $\times 100$.

PLATE 46

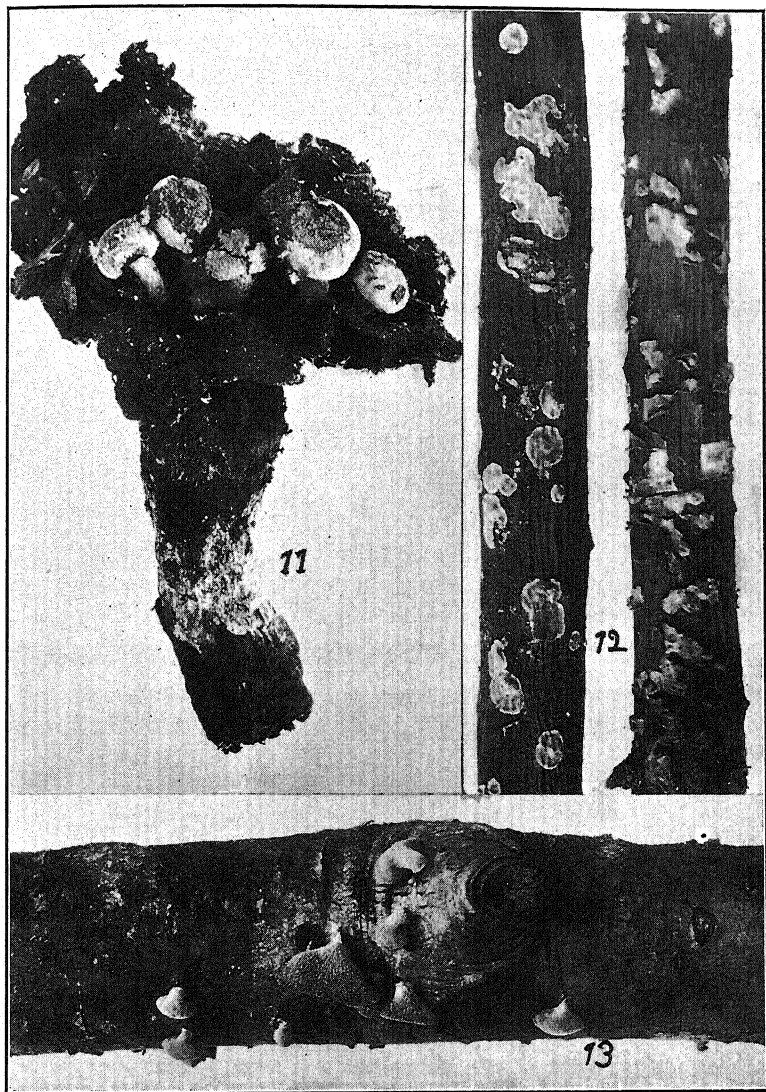
11. *Nyctalis asterophora*. Fruiting on old *Russula* sporophore. $\times 1$. (No. 14607.)
12. *Stereum Pini*. Sporophores on branches of *Pinus Strobis*. $\times 1$. (No. 14458.)
13. *Panus operculatus*. Sporophores on branch of *Betula*. $\times 1$. (No. 15002.)

PLATE 47

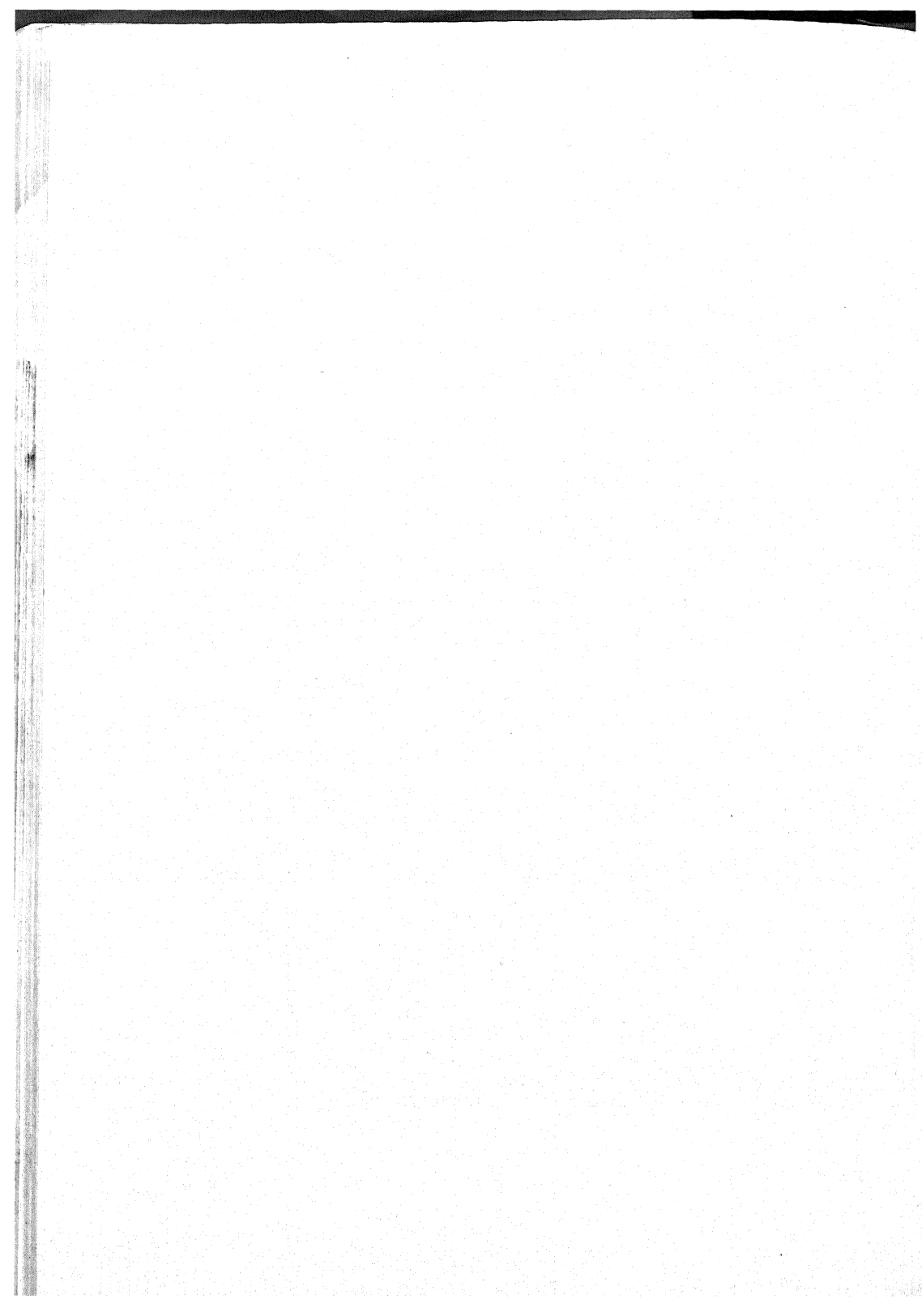
14. *Psathyra echinata*. $\times 1$. (No. 14897.)
15. *Nyctalis parasitica*. Cluster of sporophores fruiting on old *Russula* sporophore. $\times 1$. (No. 14579.)

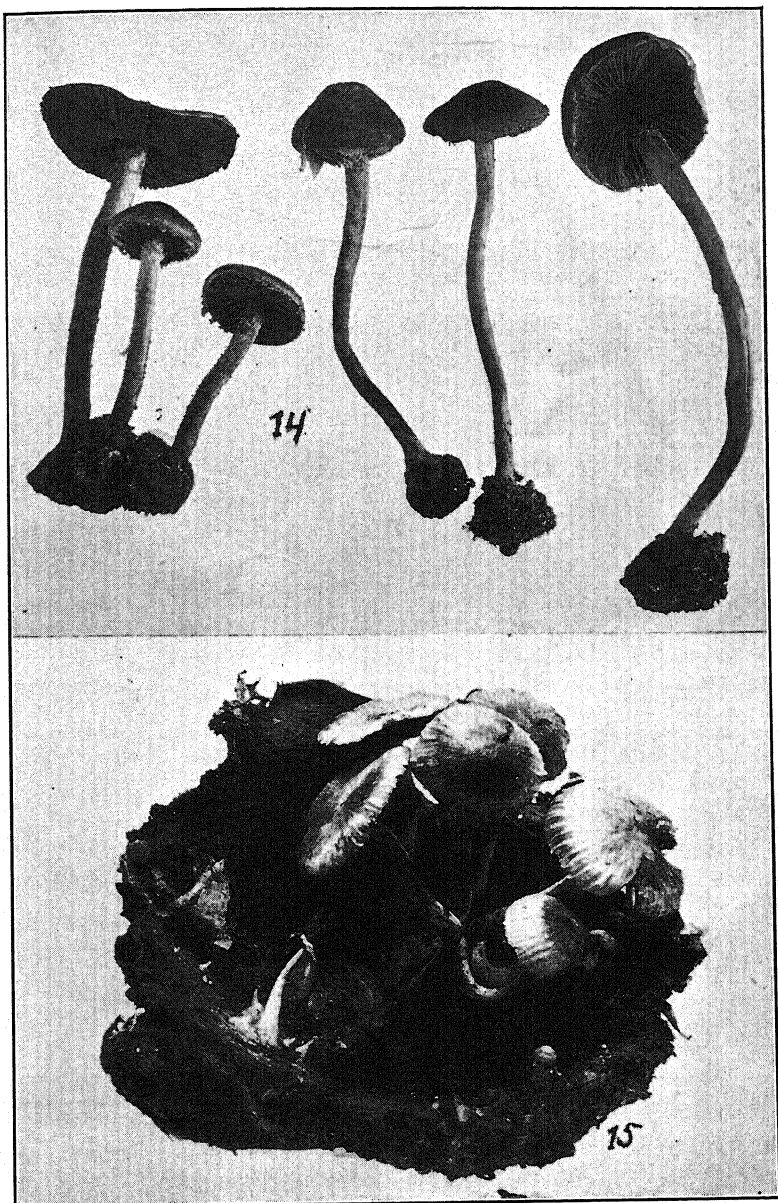


PENNSYLVANIA FUNGI

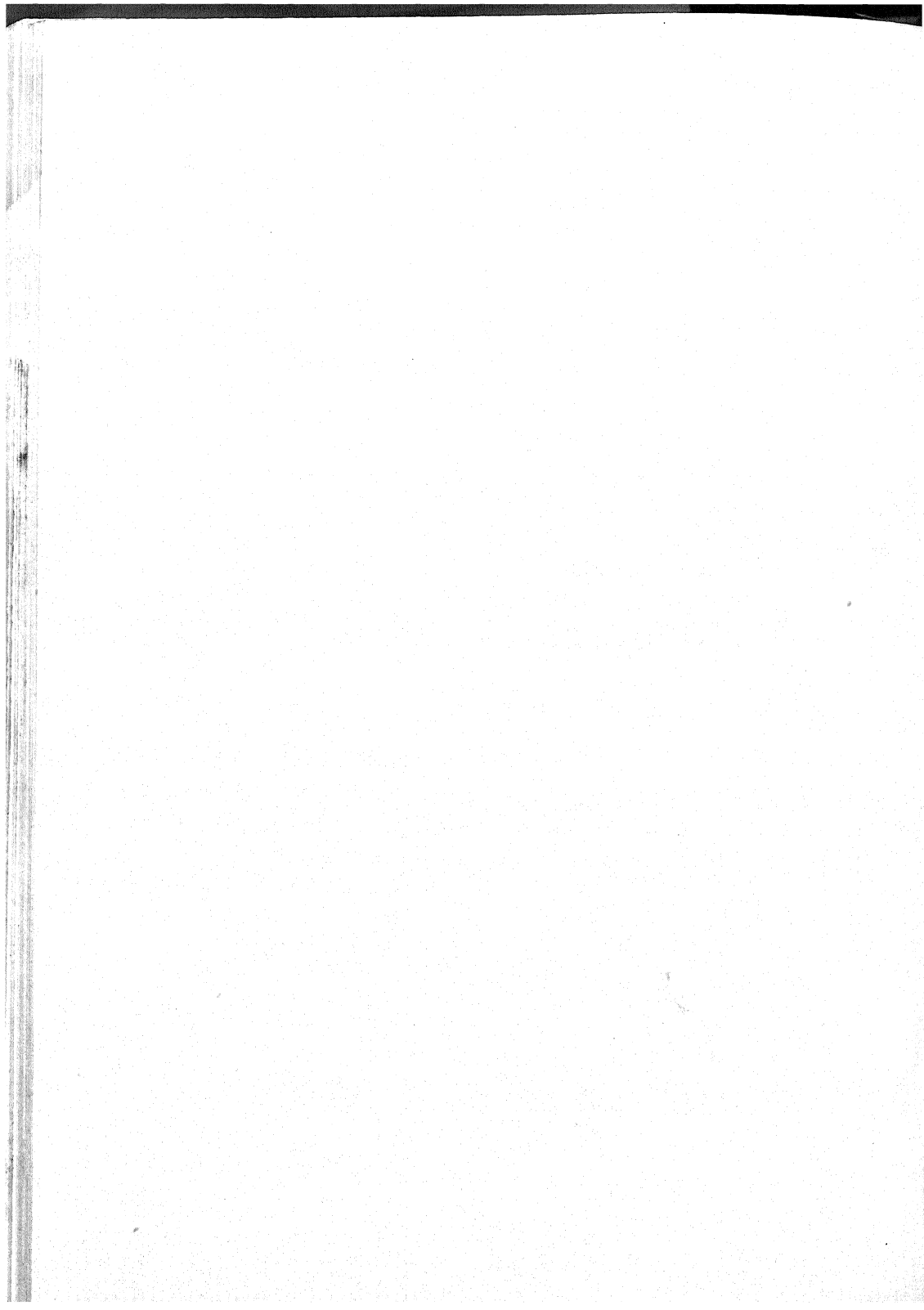


NYCTALIS ASTEROPHORA
STEREUM PINI
PANUS OPERCULATUS





PSATHYRA ECHINATA
NYCTALIS PARASITICA



ABNORMAL SPORES OF SOME GANODERMA

S. R. BOSE

(WITH 3 TEXT FIGURES)

The upper surface of the sporophore of *Ganoderma lucidum* (Leyss) Fries always becomes covered with a laccate crust which when sectioned shows a number of deep-brown elongated basidium-like cells in close clusters.

Some fructifications of *Ganoderma lucidum* obtained from the Burdwan Dt. (Bengal) in September 1930 showed in the microscopical sections of the hymenial surface (FIG. 1, 2) very promi-

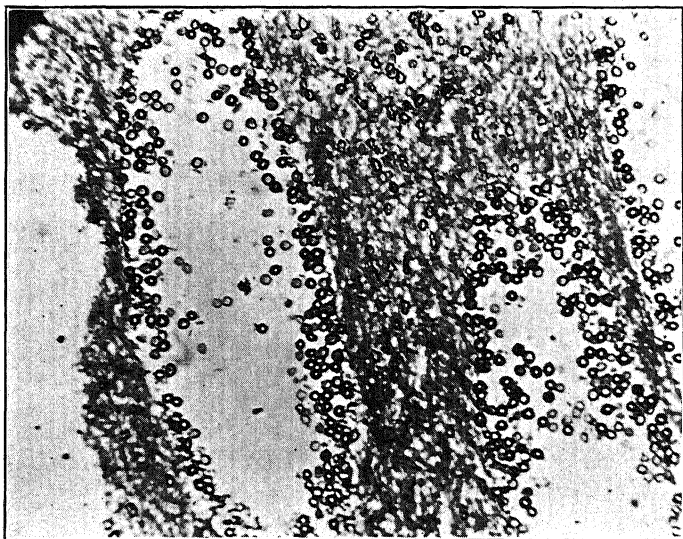


Fig. 1. Microphotograph of the longitudinal section of pore-tubes.

nently a large number of brown thick-walled big round and slightly elongated spores lining the pore-tubes, besides the basidia bearing the basidiospores; some of the pore-tubes were practically filled with such spores, here and there they were collected *enmasse* as spore-balls within the cavities of the pore-tubes; they were also

spread within the trama and the context of the sporophores. Such spores measuring 12 to 16 μ in diameter show close striations within their thick walls and their bodies are finely reticulated. The hymenial surface of these specimens showed the formation of laccate crust in patches completely effacing the porous areas here and there. A longitudinal section of this crust (FIG. 3) showed the same elongated basidium-like deep-brown cells in clusters, which normally occur on the upper surface of the fructi-

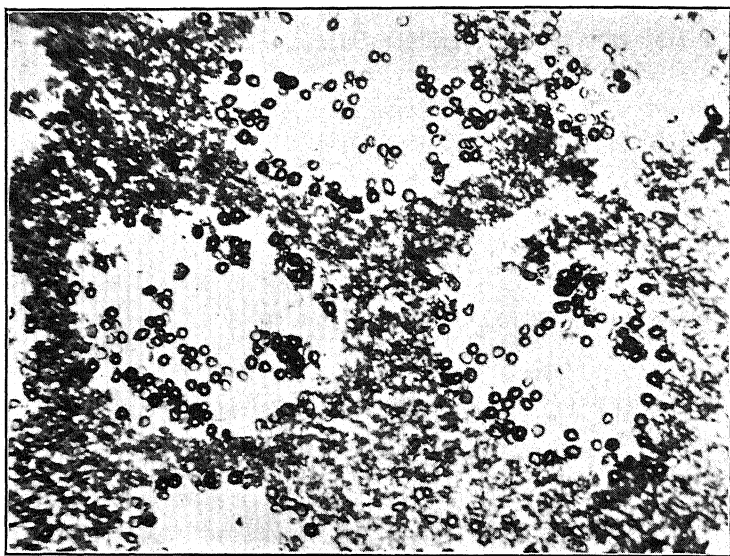


Fig. 2. Microphotograph of the transverse section of pore-tubes.

fications; adjoining the row of elongated cells was a number of the same brown thick-walled globose spores dispersed here and there within the flesh.

Subsequently in November 1931, I collected a specimen of *Ganoderma applanatum* Fries from Kurseong (Darjeeling), within the hymenial surface of which the same double-walled spores can be seen in large number.

In 1928 Malençon and Heim (1) described *Ganoderma rivulosum* Pat. and Hariot from Tonkin, in a longitudinal section of the pore-tube of which they have figured a number of such thick-walled globose spores which they have named "gasterospores,"

they are exactly like the spores of my specimens in shape and size, only their bodies are not verrucose as noted by them, but are finely reticulated. In *Ganoderma colossum* Fries, Patouillard (2) noted in 1887 such formation as internal conidia similar to the production of the *Ptychogaster* stage.

Incidentally, I may record that in the present case as also in the course of my work on Polyporaceae I have seen that the Leishmann's stain largely used in Protozoology brings out a sharp differentiation between the basidia on the one hand and the tramal-

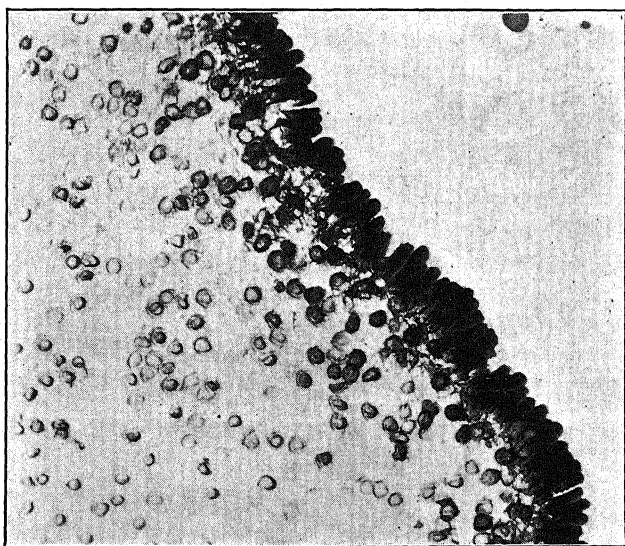


Fig. 3. Microphotograph of the longitudinal section of the crust.

and context-hyphae on the other in cases of dried specimens. Basidia become colored violet, and the tramal- and context-hyphae take on a deep-blue stain; in the case of dark and brown specimens (*i.e.*, *Hexagonia*, *Fomes*, etc.) the tramal- and context-hyphae are colored green. It is a very quick stain, the whole process is completed in about 10 to 15 minutes' time.

It may be used as follows:

I. Take a clean slide thoroughly washed in sterilized distilled water.

II. Drop Leishmann's stain from a 30 c.c. dark drop-bottle on the slide till the section is fully covered. Wait for $\frac{1}{2}$ minute only.

III. At the end of $\frac{1}{2}$ minute drop on to the slide double the corresponding number of drops of sterilized distilled water. By tilting the end of the slide allow the stain and water to mix thoroughly. Stain for about 5 to 10 minutes only.

IV. Wash the section in tap or distilled water thoroughly in a porcelain cup. This takes about 3 or 4 minutes. By means of a brush transfer the section to the slide which has been cleaned in the meantime.

V. Now place the slide leaning against a vertical wall to dry.

VI. After the slide is dried, put a drop of cedar-wood oil on the section and finally mount in xylol and balsam.

It does not seem to be a very permanent stain, usually it keeps good for about a year.

BOTANICAL LABORATORY,
CARMICHAEL MEDICAL COLLEGE,
CALCUTTA, INDIA.

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THE MICROCYCLIC SPECIES OF PUCCINIA ON SOLANUM¹

FRANK D. KERN

(WITH PLATE 48)

Several years ago, while making a systematic study of the rusts of Colombia, some specimens of *Puccinia* of evident microcyclic life-history on the genus *Solanum* were encountered. Mayor in his excellent monograph, *Contribution a l'etude des Uredinees de Colombia* (Mem. Soc. Neuch. Sci. Nat. 5: 442-599. 1913.), reported two species of this nature, *Puccinia huallagensis* P. Henn. and *P. solanicola* Mayor. According to Arthur in the North American Flora (7: 562. 1922.) a more or less similar species was reported on *Solanum* from Panama as *Puccinia solanita* (Schw.) Arth. (*Micropuccinia solanita* Arth. & Jackson). In a later number of the same work (7: 805. 1927.) Arthur reduced the name *M. solanita* to synonymy and substituted for it *Micropuccinia Solani* (Schw.) Arth. & Jackson founded on *Puccinia Solani* Schw. Whether these three really represented three valid species and if so how to distribute the Colombian specimens at hand became the problem.

While preparing the account of the Uredinales for the Mycological Explorations of Colombia published by Chardon & Toro in 1930 (Jour. Dept. Agric. Puerto Rico 14: 301-348) in conjunction with Whetzel some hasty decisions were made. No authentic specimens were available for comparison. In that paper

¹ Contribution from the Department of Botany, The Pennsylvania State College, no. 88. Publication authorized by the Director of the Pennsylvania Agricultural Exp. Station, April 18, 1933, Technical Paper no. 586.

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September 1, 1933]

P. huallagensis was maintained as valid and it was decided that Mayor's *P. solanicola* was a synonym of *P. solanita*. Why the slightly older Schweinitzian name *P. Solani* was disregarded at that time inasmuch as Arthur's combination of it with *P. solanita* was then available I cannot now explain.

More recently we have been restudying the rusts of Colombia and the problem of the *Solanum* rusts has come up again. This time we have had available through the kindness of Dr. Mayor many of his original Colombian collections. In the meantime, 1932, there appeared a contribution to our knowledge of this group of South American rusts in the form of Jackson's sixth paper of the series, The Rusts of South America, based on the Holway Collections (*Mycologia* 24: 62-186). The Holway specimens of *Solanum* rusts have also been available. Jackson recognized three previously described microcyclic species on the genus, *Puccinia imitans* from Ecuador, *P. Negeriana* from Argentina, *P. Solani-tristis* from Brazil, and described as new a fourth one, *P. aulica* Jackson & Holway, from Ecuador.

Taking into consideration other names in the literature, there were by this time the following names for consideration: *P. solanita* Schw., *P. Solani* Schw., *P. huallagensis* P. Henn., *P. solanicola* Mayor, *P. imitans* Sydow, *P. Solani-tristis* P. Henn., *P. Negeriana* Diet., *P. aulica* Jackson & Holw., *P. claviformis* Lagerh., *P. Hieronymi* P. Henn., *P. Pittieriana* P. Henn., *P. incondita*, and *P. Solanacearum* Sacc. & Sydow. All but the two last are South American. It seemed absolutely essential to have authentic specimens for comparison in order to determine the standing of these various names. The attempt to secure them was begun. Through the generous response of workers in several botanical centers at home and abroad, parts of the type specimens of all of these except *P. Pittieriana* and *P. Solanacearum* were assembled. For furnishing these specimens I am indebted to Messrs. J. C. Arthur, Purdue University; Don M. Benedict, The Academy of Natural Sciences of Philadelphia; G. Samuelsson, Naturhistoriska Riksmuseet, Stockholm; J. A. Stevenson, Bureau of Plant Industry, U. S. Department of Agriculture, Washington; N. E. Svedelius, University of Uppsala; and E. Ulbrich, Botanischer Garten und Botanisches Museum, Berlin. Through the

kindness of Dr. Arthur I have had available for examination all of the specimens of microcyclic species of *Puccinia* on Solanaceae in his herbarium.

The studies have resulted in the conclusion that there are nine species. A key has been arranged which will serve to separate them. Notes presenting synonymy, distribution, and other pertinent facts follow.

KEY TO MICROCYCLIC RUSTS ON SOLANUM

Sori evenly distributed over large areas.

Teliospores ellipsoid, not constricted, $19-24 \times 24-34 \mu$1. *P. Solani*.

Teliospores ellipsoid-clavate, constricted, $19-24 \times 34-45 \mu$. .2. *P. imitans*.

Sori definitely gregarious.

Teliospores chiefly 1-celled (mesospores), mostly $18-25 \times 21-32 \mu$.

3. *P. Negeriana*.

Teliospores chiefly, or wholly, 2-celled.

Teliospores ellipsoid, not or slightly constricted.

Teliospores broadly ellipsoid, $18-25 \times 26-35 \mu$.

Teliospores slightly constricted, pale golden-brown.

4. *P. Pittieriana*.

Teliospores usually not constricted, cinnamon-brown.

5. *P. aulica*.

Teliospores narrowly ellipsoid, $18-20 \times 35-60 \mu$.

6. *P. Solanacearum*.

Teliospores clavate or ellipsoid-clavate, more or less constricted.

Teliospores $30-55 \mu$ long.

Teliospore-wall thick, $2.5-3 \mu$, apex $5-9 \mu$2. *P. imitans*.

Teliospore-wall medium-thick, $1.5-2 \mu$, apex $4-7 \mu$.

7. *P. claviformis*.

Teliospores $23-35 \mu$ long.

Teliospore-wall thin, $1-1.5 \mu$, apex not or slightly thicker.

8. *P. Solani-tristis*.

Teliospore-wall medium, $1.5-2.5 \mu$, apex $3-6 \mu$.

9. *P. incondita*.

1. PUCCINIA SOLANI Schw.; Berk. & Curt. Jour. Acad. Phila. II.

2: 281. 1853

In the note accompanying the original latin description Schweinitz said "sori minute, distinct, compact, occupying the whole of the under surface, and only the midrib of the upper surface." The specimen at hand checks perfectly with this description. This diffuse distribution is quite distinct from the gregarious type of distribution. *P. imitans* is said to have this habit of sorus-distribution but the spores of the two are readily separable as

P. imitans has the spores constricted at the septum with the apex $5-9\mu$ as compared with no constriction and apices $4-6\mu$ in *P. Solani*.

Puccinia Solani was described from Surinam (Dutch Guiana) on *Solanum* sp. and it is known only from the type locality.

2. PUCCINIA IMITANS Sydow, Monog. Ured. 1: 273. 1902

According to the original description, this species has both the diffuse and the gregarious types of distribution of the sori. It has therefore been entered twice in the key. In the specimen I have examined the sori are gregarious. The type locality is Quito, Ecuador, on *Solanum* sp. Holway collected it at the same place on *Solanum utile* in 1920 (See Jackson, Mycologia 24: 82. 1932).

3. PUCCINIA NEGERIANA Diet. in Engl. Bot. Jahrb. 22: 351.
1896. (May)

Puccinia Hieronymi P. Henn. Hedwigia 35: 234. 1896. (Oct.)

P. Negeriana was described from Chile on *Solanum furcatum* and *P. Hieronymi* from Argentine on *S. incisum*. After studying and comparing the types of these I am inclined to put them together. I find no differences sufficient to maintain them as separate entities. The numerous mesospores characterize the species. The two names were published the same year but Dietel's publication has priority by a few months. Jackson has reported the species from Argentine on an undetermined *Solanum*.

4. PUCCINIA PITTIERIANA P. Henn. Hedwigia 43: 147. 1904

Arthur has given a good account of the history of this rust in Science, N. S. 51: 246-7. 1920. Up to that time it had been collected in Costa Rica, the type locality, in 1903 and 1904 by H. Pittier, and by Holway in 1916 on the wild potato, and in Ecuador in 1918 by A. Pachano on both potatoes and tomatoes. I have examined the specimen on the tomato and find that it agrees perfectly with those on the potato. Arthur also reports this rust from Peru, collected by Abbott in 1929 on *Solanum tuberosum* (Bull. No. 2 Est. Exper. Agric. Soc. Nac. Agraria, Lima). In

that report Arthur indicates the presence of urediniospores. In a recent letter Dr. Arthur writes that this is an error. The species is now known also from Colombia (Jour. Dept. Agric. Puerto Rico 14: 331. 1930.) and from Venezuela where it was collected by Chardon (no. 1018) in 1932. A discussion of the possible origin of the potato rust is given by Arthur in Science, N. S. 53: 228-229. 1921.

5. PUCCINIA AULICA Jackson & Holw. Mycologia 24: 82. 1932

This species has been described recently from Ecuador on *Solanum montanum*. No other collections are reported. The spores resemble those of *P. Solani* but are thinner-walled and darker in color. The two species are very different in habit.

6. PUCCINIA SOLANACEARUM Sacc. & Sydow, in Sacc. Syll.
Fung. 14: 358. 1899

Puccinia Solani Cooke, Grevillea 7: 61. 1878. Not *P. Solani* Schw. 1853.

This was described from East India, Sutlej Valley, on *Solanum* sp. Of this I have not had an original specimen. The spores differ materially in shape and size from the South American forms that have been studied. In Saccardo, vol. 7, p. 718, the reference of a rust on *Chamaesaracha nana* from California to this species is an error. It belongs to *Puccinia Chamaesarachae* Sydow.

7. PUCCINIA CLAVIFORMIS Lagerh. Tromsö Mus. Aarsh 17:
53. 1895

Aecidium solanitum Schw.; Berk. & Curt. Jour. Acad. Phila. II.
2: 283. 1853 (hyponym).

Dicaeoma claviforme Kuntze, Rev. Gen. 3^a: 468. 1898.

Puccinia huallagensis P. Henn. Hedwigia 43: 158. 1904.

Puccinia solanicola Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 505.
1913.

Puccinia solanita Arth. Mycologia 14: 19. 1922.

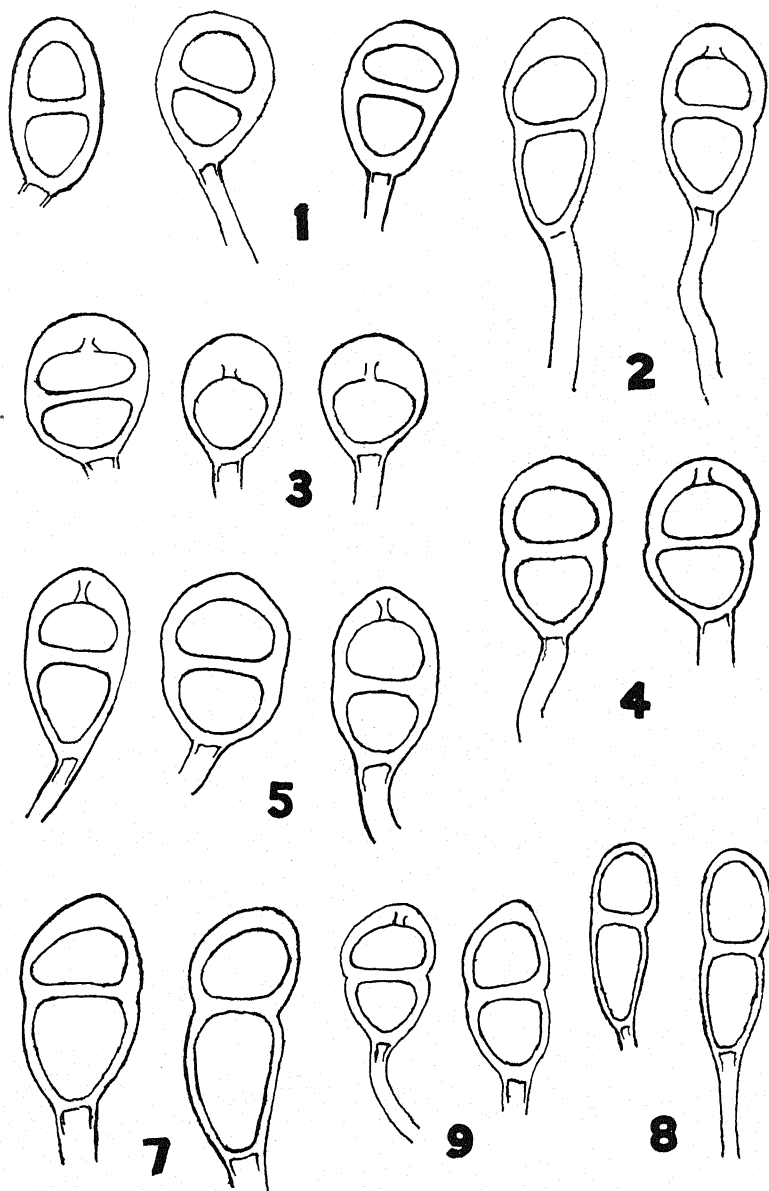
Micropuccinia solanita Arth. & Jackson, N. Am. Flora 7: 562.
1922.

Judging from the number of collections, this is the most common species. The type locality is Surinam where it was collected on an undetermined species of *Solanum*. It has been collected in Colombia on *S. hirtum*, *S. straminifolium*, *S. torvum*, *S. aff. myrianthum*, *S. aff. ovalifolium*, and numerous times on undetermined species. I have examined fourteen collections from Colombia. Mayor reports at least half a dozen more collections which doubtless belong here but which I have not seen. I have examined a specimen collected in Trinidad by Seaver on *Solanum* sp. (See Mycologia 14: 19. 1922). It is reported from Panama on *Solanum Donnell-Smithii* (N. Am. Flora 7: 562. 1922.) and on *S. diversifolium* (N. Am. Flora 7: 805). Lagerheim's name *Puccinia claviformis* was founded on the same specimen which Schweinitz had called *Aecidium solaninum*. The original publication of that name by Berkeley and Curtis stated that "the specimens are not in a sufficiently good state to enable us to draw up a specific character." On that account Lagerheim described the fungus as a new species. I am inclined to agree with him that the Schweinitz name *solaninum* never was adequately established. This makes the oldest name for the species *P. claviformis*. I am convinced that taking up the name *P. Solani* Schw. for this species and listing *P. Solani-tristis* P. Henn. as a synonym, as is done in the N. Am. Flora (7: 805), is an error since my investigations show that these are separate and distinct species.

Mayor found some spores with three or four cells as indicated by his illustration (Mem. Soc. Neuch. Sci. Nat. 5: 506, f. 34). There is a specimen in the Arthur herbarium from Panama on *Solanum* sp. with a note that a fraction of one percent of the spores are of this sort. This condition must be rare as I have failed to note it in the numerous specimens examined. Arthur in the N. Am. Flora (7: 805) suggests that this "species is correlated with the heteroecious species, *Puccinia tubulosa* (Pat. & Gaill.) Arth., the telia being morphologically similar, and the hosts agreeing with the aecial hosts of the heteroecious species."

8. PUCCINIA SOLANI-TRISTIS P. Henn. Hedwigia 22: 236. 1896

This species is characterized by the constricted thin-walled spores, not or only slightly thickened at the apex. This set of



PUCCINIA ON SOLANUM

spore characters is different from any of the other species. The type locality is Brazil, on *Solanum tristis*. Jackson (Mycologia 24: 83. 1932.) reports it on *S. Neves-Armondii*, *S. rufescens*, and *Solanum* sp., all from Brazil. Altogether there are six Holway collections. The one on *S. rufescens* and one of the specimens on an undetermined *Solanum* are from the type locality, Therezopolis, Rio de Janeiro, Brazil.

9. PUCCINIA INCONDITA Arth. Bull. Torrey Club 45: 148. 1918

A North American species described from Texas on *Solanum triquetrum*. Arthur suggests that it is similar in form to *Puccinia Pittieriana* but that it has slightly smaller spores. In general aspect the small spores resemble those of *Puccinia Solani-tristis* but they are broader, thicker-walled, and have more of a tendency to be thicker at the apex. It is known only from the type locality.

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EXPLANATION OF PLATE 48

1, *Puccinia Solani* Schw.; 2, *Puccinia imitans* Sydow; 3, *Puccinia Negeriana* Diet.; 4, *Puccinia Pittieriana* Arth.; 5, *Puccinia aulica* Jackson; 7, *Puccinia claviformis* Lagerh.; 8, *Puccinia Solani-tristis* P. Henn.; 9, *Puccinia incondita* Arth.

All of these, with the exception of *Puccinia Pittieriana*, were drawn from the type specimen. Magnification 1:625.

THE STANDING OF TWO SPECIES OF UROMYCES ON PANICUM¹

H. W. THURSTON, JR.

(WITH TEXT FIGURES)

While engaged in a critical study of the rusts of Colombia together with F. D. Kern and H. H. Whetzel, a problem was encountered involving two species of *Uromyces* on *Panicum*. The solution of this problem so far as Colombian collections were concerned has thrown some light on certain misconceptions current in the rust literature of North America, so that a brief report of these studies seems desirable.

In studying the Mayor collections, a specimen no. 242, said to be on *Panicum lanatum*, which Mayor had called *Uredo Henningsii*,² was found to bear both urediniospores and teliospores and thus was obviously not to be referred to the form genus *Uredo*. The teliospores were one-celled, but did not agree with the description of *U. leptodermus*, the only North American *Uro-*

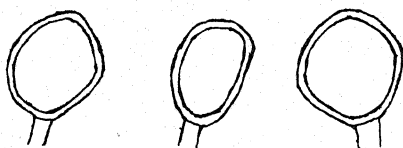


FIG. 1. *Uromyces leptodermus* (the type).

myces reported on this host species. Sydow had recently described *Uromyces costaricensis* from Costa Rica on *Panicum altissimum* and the Mayor specimen seemed to fit this description. Through the kindness of Mr. G. Samuelsson, Director of the Botany Department, Naturhistoriska Riksmuseet, Stockholm, a part of the type of *U. leptodermus* was made available for comparison.

¹ Contribution from the Department of Botany, The Pennsylvania State College, no. 87. Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station, April 18, 1933, as Technical Paper No. 587.

² Mem. Soc. Neuch. Sci. Nat. 5: 578. 1913.

Doctor Sydow kindly sent a portion of the type of his *U. costaricensis*. These two specimens proved to be as different as their descriptions had led us to believe and the Mayor specimens checked up exactly with the type of *U. costaricensis*. Inasmuch as telia are rare on many tropical grass rusts, and the uredinia of both species in question are very similar, this led to the suspicion that perhaps *U. costaricensis* was really the more common form in the western hemisphere since *U. leptodermus* was originally described from East India. Therefore, as many specimens as possible were assembled for study. Doctor J. C. Arthur kindly supplied from his herbarium several specimens which proved valuable.

The two rusts proved to be practically indistinguishable in the uredinal stage, but easily separable in the telial stage. Teliospores were found on collections from Mona Island, Jamaica, Costa Rica, and Brazil, all labelled *U. leptodermus* which, however, agree much better with *U. costaricensis*. It is of additional interest to note that all of these were on host species belonging to a distinct section of *Panicum* known as *Lasiacis*, while *U. costaricensis* as described by Sydow was said to be on *Panicum altissimum*. Our specimen of the type of *U. costaricensis*, as well as the Mayor specimen, we referred to Dr. A. S. Hitchcock who thinks they are both *Lasiacis sorghoidea*. If this is true it means that all the specimens we have found bearing telia that are here referred to *U. costaricensis* are confined to the *Lasiacis* section of *Panicum* which is regarded by Hitchcock and others as a separate genus under the name *Lasiacis*. On the other hand, *U. leptodermus* was described on *P. javanicum* belonging to a very different section of a *Panicum*. We have found two collections, one from St. Croix and the other from Santo Domingo, which bear teliospores with the uniform wall thickness characteristic of *U. leptodermus*. Both of these are on *Panicum barbinode*, which is more or less related to *P. javanicum*, and quite unlike the *Lasiacis* species. It seems, therefore, that *U. leptodermus* does occur in the West Indies, but as suggested above, most of what has been passing as this species is better referred to *U. costaricensis* and further that the hosts can be used to distinguish these two rusts in the absence of teliospores.

There is another situation which complicates the matter as here presented. Four collections, two on *Panicum fasciculatum* from

Panama and Puerto Rico and two on *P. trichoides* from Venezuela and Puerto Rico, have 1-celled teliospores practically identical with those of *U. leptodermus* and in addition 2-celled spores of the ordinary *Puccinia*-type. These doubtless represent a species of *Puccinia* which is correlated with *Uromyces leptodermus* as indi-

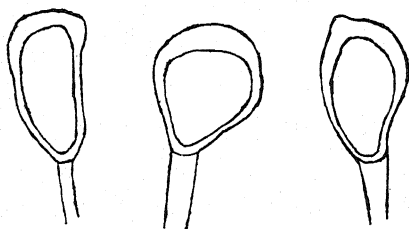


FIG. 2. *Uromyces costaricensis* (the type).

cated by urediniospores, teliospores, and hosts. Whether the *Puccinia* species is properly called *P. Huberi* P. Henn. or *P. levis* Magn., or by one of the other *Puccinia* names which have been applied to *Panicum* rusts, is another question.

Following is a list of all collections at hand bearing telia of these two species of *Uromyces*.

UROMYCES LEPTODERMUS Sydow; Sydow & Butler, Ann. Myc.
4: 430. 1906

On *Panicum javanicum* Poir. Dehra Dun. India, Sept. 22, 1905.
E. J. Butler Type.

Panicum barbinode Trin. Haina, Santo Domingo, March
11, 1926, Kern & Toro no. 45; St. Croix, March, 1923,
F. J. Seaver no. 880.

UROMYCES COSTARICENSIS Sydow, Ann. Myc. 23: 312. 1925

On *Lasiacis divaricata* (L.) Hitch. Mona Island, Dec. 20,
1913, F. L. Stevens no. 6145; Santo Domingo, June 12,
1931, R. Ciferri no. 4171; La Caja pr. San Jose, Costa
Rica, Dec. 12, 1924, Sydow, Fungi exotici exsiccati no.
559.

Lasiacis ligulata Hitch. & Chase. Rio Janeiro, Brazil, Sept.
16, 1921, E. W. D. Holway no. 1117; Sept. 23, 1921, no.
1148.

Lasiacis sorghoidea (Desv.) Hitch. & Chase (*Panicum altissimum* Meyer, *Lasiacis Schwartziana* Hitch.) Grecia, Costa Rica, Jan. 1, 1925, Sydow no. 178 *Type*; Jamaica, Feb. 1891, R. Thaxter, no number; Andes Centrales, Dept. Antioquia, Eltoblado on dissus de Medellin, Colombia, Mayor no. 242.

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PLASMOPARA HALSTEDII ON CINERARIA

D. L. GILL

A downy mildew of cineraria (*Senecio cruentus* DC.) was encountered during the autumn of 1932 by H. H. Whetzel. It was reported that about ten per cent of the plants in a greenhouse at Hempstead, Long Island, were affected, and the disease was causing a considerable loss. The plants were of the *multiflora* type, which is the common potted cineraria, the seed having been obtained from Germany. As a downy mildew had not been reported previously on this host, an investigation was undertaken under the direction of Professor H. M. Fitzpatrick.

The lesions appear on the under sides of the leaves as small white spots and on the upper sides as slightly browned areas. They are usually from 0.5 to 3 cm. in diameter although in some cases they include a larger area. The part of the leaf bearing these spots gradually dies, the color changing to a dark brown. The death of the remainder of the leaf soon follows.

Examination of the fungus showed that it belongs to the genus *Plasmopara*. It was compared with the description of *Plasmopara Halstedii* (Farl.) Berl. & De-Toni which is given by Wilson¹ as: "Hypophyllous, on cotyledons and leaves, the affected area small, 1-3 mm., or extending over the entire leaf; conidiophores fasciculate, slender, 300-750 μ , 3-5 times branched, ultimate branchlets 8-15 μ long, verticillate below the apex of the branching axis which is frequently swollen and ganglion-like; conidia oval or elliptic, 18-30 \times 14-25 μ ; oöspores 30-32 μ ; epispore yellowish-brown, somewhat wrinkled."

The general characters of the fungus on cineraria fit this description. One hundred and one measurements were made of the sporangiophore and terminal branchlet lengths and 110 measurements of the spore size. The branches on the sporangiophores were counted. The number of branches and the terminal branch-

¹ Wilson, G. W. Studies in North American Peronosporales—II. Phytophthora and Rhysosporae. Bull. Torrey Bot. Club 34: 387-416. 1907.

let lengths compare well with the description. The figures for the sporangiophore length lie in the lower range and below the 300–750 μ given by Wilson. They were found to be 247–640 μ with a mean of 385.44 ± 8.23 and a standard deviation of 82.69. The spores are slightly below the range of spore size, being from $15\text{--}30 \times 13\text{--}23 \mu$ as compared with $18\text{--}30 \times 14\text{--}25 \mu$. The measurements of the spore lengths have a mean of $19.67 \pm .286$ with a standard deviation of 1.74. The widths have a mean of $16.59 \pm .199$ and a standard deviation of 2.09. No oöspores were found in any of the material examined.

Specimens of *Plasmopara Halstedii* were examined on *Bidens frondosa* L. and *Rudbeckia hirta* L. These are clearly the same fungus.

It is not thought that the difference in sporangiophore length and spore size is sufficient to prevent the inclusion of the fungus on cineraria in this species, especially since Wilson says: "This is the most unsatisfactory species of a difficult genus. The conidiophores are very variable, especially in the laxity of their branches and the development of the ganglion-like swelling from which the ultimate branchlets arise. Several forms are clearly distinguishable and are apparently valid species, but further search has invariably brought to light intermediate forms connecting the extremes with the typical form and with other forms. Until an exhaustive study of a much greater quantity of material, both conidial and oösporic, is possible than is at present at hand, segregation of this species had best not be attempted."

Therefore, it is concluded that the fungus on *Senecio cruentus* DC. is *Plasmopara Halstedii* (Farl.) Berl. & De-Toni. A search of the literature has failed to reveal a record of *Plasmopara Halstedii* on this host. However, *Bremia Lactucae* Regel has been reported as occurring on cineraria in Europe.

DEPARTMENT OF PLANT PATHOLOGY,
CORNELL UNIVERSITY,
ITHACA, NEW YORK.

ANNOTATED INDEX OF THE RUSTS OF COLOMBIA¹

F. D. KERN, H. W. THURSTON, JR., AND H. H. WHETZEL

In 1930 two of the present authors, Kern and Whetzel (5), contributed the account of the Uredinales to the Mycological Explorations of Colombia published by Chardon and Toro in the Journal of the Department of Agriculture of Puerto Rico, 14: 301-348. Not excluding previous reports of rusts from this area by Léveillé (7), Earle (Dietel) (2), Prinzessin Therese von Bayern (11), Lindau (8), Sydow (10), and Kern and Chardon (4), the chief basis of information regarding Colombian rusts at that time was the careful and comprehensive monograph of Mayor in 1913 entitled Contribution à l'étude des Uredinees de Colombie (9).

As a result of subsequent studies, during which time many additional specimens have been available to us together with new information on tropical rusts in recently published papers, we have made many changes and additions to our presentation of 1930. A further explanation of why the present list differs so much from the one of 1930 seems in order. Changes may be due to the discovery of additional spore-forms, or they may be due to additional characters discoverable from the specimens but not from descriptions, or to mistaken identity of hosts, or to some combination of these or other new data.

The most important influence in the preparation of this revised list has been the availability of a large collection representative of the specimens on which the Mayor paper was founded. These were furnished in a fine spirit of coöperation by Dr. Mayor. Illustrative of the conceptions that become changed when specimens supplement descriptions, a few concrete cases are being cited in these prefatory remarks.

The case of *Uredo caucensis* Mayor is interesting. It was originally described as on *Vitis* sp. Although it did not agree too well,

¹ Contribution from the Department of Botany, The Pennsylvania State College, no. 89, and from the Department of Plant Pathology, Cornell University.

we jumped at a conclusion and referred it to the grape rust, *Phakopsora Vitis* in our 1930 paper. With the specimen at hand we discovered telial columns of the style of *Cronartium*. Close observation of the host indicated the need for re-examination. Soon some phanerogamic botanists pronounced it to be *Cissus rhombifolia*. It was then only a step to the identity of *Uredo caucensis* Mayor and *Crossopsora Wilsoniana* from the West Indies and Central America on the same host. *Uredo Salviarum* Mayor on *Salvia* had been placed by Arthur as a synonym of *Puccinia salviicola* Diet. & Holway. With only uredospore size, color, and wall characters available in the description, this reference seemed correct and we accepted it. With the additional information as to the peculiar pore characters, gained from an examination of the specimen, we were able to show its undoubted relation to *Puccinia Ballotaeflorae* Long. In the case of *Aecidium Gymnolomiae* Mayor discovery of uredinia and telia on the type specimen and the correction of an error in the original determination of his host enabled us to refer his species to *Puccinia Steiractiniae*. Comparison of *Uredo Caleae* Mayor with the uredo stage of *Puccinia Caleae* Arth., known from Mexico and Brazil, has given us an assurance of identity which we previously suspected but hesitated to assume. In addition to the determined specimens sent us by Dr. Mayor, he was kind enough to place in our hands a number of undetermined collections which proved to be helpful in adding to our information.

Five out of the six Baker specimens reported by Earle in 1899 have been available and examination has completely changed our conceptions of two of them. What was called *Uromyces Manihotis* P. Henn. is undoubtedly *U. Janiphae* (Wint.) Arth. and what was thought to be *Prospodium appendiculata* (Wint.) Arth. on some Bignoniaceae turns out to be *Prospodium Von Guntenii* (Mayor) Kern & Whetzel on *Lippia* sp.

Not only have our ideas changed with a study of additional specimens from the region concerned, but also with the study of other tropical rusts. Our continued investigations of the rusts of the West Indies, especially those of Santo Domingo, frequently have thrown light on relationships of forms in Colombia. We have also found most useful both the papers of Arthur (1) and

Jackson (6) on South American rusts and the Holway specimens, many of which we have had for examination.

We cannot overemphasize the value of checking up specific conceptions through the examination of type specimens. Without this procedure we could not have untangled the microcyclic rusts on *Solanum* or the *Uromyces* species on the grasses *Lasiacis* and *Panicum*. We have been very fortunate in being able to secure numerous type specimens which have enabled us to settle various problems which otherwise would have been difficult or impossible.

While additional rust names appear in the present list as a result of the straightening out process applied to old specimens, we have not been without new specimens not before available. In 1930 W. A. Archer collected in Colombia and through Mr. J. A. Stevenson, in charge of the mycological collections, Bureau of Plant Industry, U. S. Department of Agriculture, these have been placed at our disposal. These were largely determined by Mr. R. W. Davidson, then of that office, but in a residue undetermined by him we have found five new species.

Of the 215 species reported in this paper, 37 must still be assigned to the form-genera *Aecidium* and *Uredo*. The 178 whose life histories are known are distributed to 21 genera but in a very uneven manner since 102 belong to *Puccinia* and 32 to *Uromyces*. Eleven genera are represented in the list by one species each. Practically all of the information has been built up during the past twenty years. The large number of species referable only to *Aecidium* and *Uredo* emphasizes the incompleteness of our knowledge. Prior to Mayor's monograph eleven species were known from Colombia, Mayor reported 149, and our previous paper recognized 204. It should be borne in mind that these figures are not exactly comparable since specific conceptions are not identical in these reports but they give a rough idea of the accumulation of the knowledge of the rust flora of this region. It is interesting to note that of the large number of new species, 83, described in Mayor's monograph, 77.1 per cent are still regarded as valid. This serves to illustrate how little was known of the region at this time of his pioneer work.

To make the list an index to the fungi we have arranged the genera alphabetically and the species in like order under the genera.

In order to facilitate a ready means of ascertaining our conception of species we have included in their alphabetical sequence rust names, not accepted by us, which have been used in papers dealing with Colombian species. A complete index of the 331 hosts and a selected bibliography follows.

For responding promptly and generously to our special calls for assistance, particularly as regards the furnishing of much needed authentic or type specimens, acknowledgments are due to Messrs. J. C. Arthur, Purdue University; Don M. Benedict, The Academy of Natural Sciences of Philadelphia; H. S. Jackson, University of Toronto; G. Samuelsson, Natürhistoriska Riksmuseet, Stockholm; J. A. Stevenson, Bureau of Plant Industry, U. S. Department of Agriculture; N. E. Svedelius, University of Upsala; H. Sydow, Berlin; E. Ulbrich, Botanischer Garten und Botanisches Museum, Berlin; and William H. Weston, Jr., Harvard University.

It is with pleasure that the authors acknowledge their indebtedness to Messrs. C. E. Chardon, R. A. Toro, and J. A. B. Nolla, of Puerto Rico, for placing in our hands their collections and making possible the beginning of these studies. Except for the encouragement and continued support of these men, Dr. Mayor, and the officers of the institutions with which we are connected, this work would not have been undertaken.

AECIDIUM (Form genus).

AECIDIUM ADENARIAE Mayor, Mem. Soc. Neuch. Nat. Sci. 5: 556. 1913.

On *Adenaria floribunda* H.B.K., Toro 305.

Adenaria floribunda purpurata (H.B.K.) Koehne, Mayor 175.

AECIDIUM AMAGENSE Mayor. Error for *Synchytrium citrinum* (Sydow) Gäumann.

AECIDIUM (?) ARIDUM Diet. & Neg. Engl. Bot. Jahrb. 27: 13. 1899.

On *Berberis rigidifolia* H.B.K., Paramo de Fontibon, Eastern Cordillera, dept. Santander del Norte, Sept. 16, 1932, C. E. Chardon 759.

This specimen has on it only a small amount of rust which is old and badly parasitized. The gross and microscopic characters agree with those given for *A. aridum* and we are referring our

specimen to this species but not without some doubt. There are several other species described from South America on the genus *Berberis*. *A. aridum* is known from Brazil and Chile.

AECIDIUM BOCCONIAE Mayor. See *Coleosporium Bocconiae* (Mayor) Sydow.

AECIDIUM BOGOTENSE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 563. 1913.

On *Geranium multiceps* Turcz., Mayor 34.

Not to be confused with an aecial stage associated with *Uredo unilateralis*. See note under that species.

AECIDIUM BOMAREAE Mayor. See *Puccinia Bomareae* P. Henn.

AECIDIUM BORRERIAE Pat. in Duss, Enum. Champ. Guadeloupe 7. 1903.

On *Hemidiodia ocimifolia* (Willd.) K. Schum., Mayor 265.

AECIDIUM CAPSICI Kern & Whetz. Jour. Dept. Agr. Puerto Rico 14: 341. 1930.

On *Capsicum baccatum* L., Toro 197; Chardon & Nolla 510.

Davidson (Mycologia 24: 226. 1932) suggests that this may be the aecial stage of *Puccinia paulensis* Rangel. The absence of both pycnia and telia in both collections of *A. Capsici* indicate a quite different life cycle.

AECIDIUM CISSI Wint. See *Endophyllum circumscriptum* (Schw.) Whetz. & Olive.

AECIDIUM CLIBADII Sydow. See *Endophyllum decoloratum* (Schw.) Whetz. & Olive.

AECIDIUM ERIGERONTIS Kern & Whetz. See *Puccinia Cyperi* Arth.

AECIDIUM GYMNOLOMIAE Mayor. See *Puccinia Steiractiniae*.

AECIDIUM HELIOPSIDIS Mayor. See *Puccinia Bimbergi* Mayor.

AECIDIUM LANTANAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 567. 1913.

On *Lantana hispida* H.B.K., Mayor 213.

We are following Jackson (Mycologia 24: 63. 1932) in maintaining this as distinct from *Aecidium Verbenae* Speg. although

Arthur (N. Am. Flora 7: 635. 1924) has combined the two. Jackson has reported this species from Brazil and Ecuador.

AECIDIUM LIABI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 576. 1913.

On *Liabum igniarum* (H. & B.) Less., Mayor 197.

Reported also from Mexico by Arthur (N. Am. Flora 7: 643. 1924).

AECIDIUM MANETTIAE Kern & Whetz. Jour. Dept. Agr. Puerto Rico 14: 343. 1930.

On *Manettia Toroi* Standley, Toro 361.

AECIDIUM MEDELLINENSE Mayor. Error for *Synchytrium* sp.

AECIDIUM PARAMENSE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 571. 1913.

On *Eupatorium obscurifolium* Hieron., Mayor 43.

AECIDIUM SPEGAZZINII De-Toni in Sacc. Syll. Fung. 7: 802. 1888.

On *Erigeron bonariensis* L., Mayor 19.

The spores of this do not agree with those of *Puccinia Cyperi*. It may turn out to be *Puccinia Asterum*.

AECIDIUM STACHYTARPHETAE P. Henn. See *Endophyllum Stachytarphetae* (P. Henn.) Whetz. & Olive.

AECIDIUM VERNONIAE-MOLLIS Mayor. See *Coleosporium Vernoniae* Berk. & Curt.

AECIDIUM WEDELIAE Earle. See *Endophyllum decoloratum* (Schw.) Whetz. & Olive.

ALVEOLARIA Lagerh. Ber. Deuts. Bot. Ges. 9: 346. 1891.

ALVEOLARIA CORDIAE Lagerh. Ber. Deuts. Bot. Ges. 9: 346. 1891.

On *Cordia ferruginea* (Lam.) R. & S., Chardon 562.

Cordia laxiflora H.B.K., Mayor 156.

CEROTELIUM Arth. Bull. Torrey Club 33: 30. 1906.

CEROTELIUM DESMIUM (Berk. & Br.) Arth. N. Am. Flora 7: 698. 1925.

Uredo Gossypii Lagerh. Jour. Myc. 7: 48. 1891.

- On *Gossypium barbadense* L., Toro 237; Chardon 170.
Gossypium hirsutum L., Chardon 590.
Gossypium peruvianum Cav., Chardon & Nolla 222; Chardon 15.
Gossypium cf. *religiosum* L., Mayor 200.
Gossypium sp., Mayor 63.
- CEROTELIUM FICI (Cast.) Arth. Bull. Torrey Club 44: 509. 1917.
- On *Ficus Carica* L., Toro 278; Chardon & Nolla 247; Chardon 57, 378; L. Pardo Navarro 571.
- CHRYSOCELIS Lagerh. & Diet. Mem. Soc. Neuch. Sci. Nat. 5: 542. 1913.
- CHRYSOCELIS LUPINI Lagerh. & Diet. Mem. Soc. Neuch. Sci. Nat. 5: 542. 1913.
- On *Lupinus* sp., Mayor.
- COLEOSPORIUM Lév. Ann. Sci. Nat. III. 8: 373. 1847.
- COLEOSPORIUM BOCCONIAE (Mayor) Sydow, Monog. Ured. 4: 343. 1923.
- Aecidium Bocconiae* Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 560. 1913.
- On *Bocconia frutescens* L., Mayor 202b.
- COLEOSPORIUM DOMINGENSE (Berk.) Arth. Am. Jour. Bot. 5: 329. 1918.
- Coleosporium Plumierae* Pat. Bull. Soc. Myc. Fr. 18: 178. 1902.
- On *Plumiera alba* L., Chardon & Nolla 249.
Plumiera rubra L., Chardon & Nolla 404.
Plumiera sp., Chardon 13.
- COLEOSPORIUM ELEPHANTOPODIS (Schw.) Thüm. Myc. Univ. 953. 1878.
- On *Elephantopus mollis* H.B.K., Chardon & Nolla 276, 574; Chardon 33, 715.
Elephantopus scaber L., Mayor 185a.
Elephantopus spicatus (Juss.) Rohr., Chardon & Nolla 315, 446.
Elephantopus sp., Baker 86 (specimen not seen).

COLEOSPORIUM EUPATORII Arth. Bull. Torrey Club 33: 31. 1906.

On *Hebeclinium macrophyllum* (L.) DC. (*Eupatorium macrophyllum* L.), Chardon 719; Mayor 74.

COLEOSPORIUM FISCHERI Mayor. See *Coleosporium Ipomoeae* (Schw.) Burr.

COLEOSPORIUM IPOMOEAE (Schw.) Burr. Bull. Ill. Lab. Nat. Hist. 2: 217. 1885.

Coleosporium Fischeri Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 550. 1913.

On *Ipomoea* aff. *caloneura* Meiss., Mayor (not seen).

Ipomoea sp., Chardon 541; Mayor 287.

Jacquemontia sp., Toro 288.

Quamoclit angulata (Lam.) Bojer, Mayor 286a.

Quamoclit coccinea (L.) Moench., Chardon & Nolla 361.

COLEOSPORIUM VERNONIAE Berk. & Curt. Grevillea 3: 57. 1874.

Aecidium Vernoniae-mollis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 570. 1913.

On *Vernonia* cf. *mollis* H.B.K., Mayor 172d.

Sydow (Monog. Ured. 4: 307. 1924) has pointed out that the Mayor collection here cited is the aecial stage of a *Coleosporium* and not an *Aecidium*. Our examination of the specimen verifies this. The transfer of *Aecidium Vernoniae-mollis* to *Puccinia Vernoniae-mollis* (Jour. Dept. Agr. Puerto Rico 14: 339. 1930) was an error.

CRONARTIUM Fries, Obs. Myc. 1: 220. 1815.

CRONARTIUM PRAELONGUM Wint. Hedwigia 26: 24. 1887.

On *Eupatorium conyzoides* Vahl., Mayor 206a.

Eupatorium inulifolium H.B.K., Mayor 54.

Eupatorium morifolium Miller, H. H. Smith 669.

Eupatorium odoratum L., Chardon 643a, 686.

Eupatorium pomaderrifolium Benth., Mayor 55.

Eupatorium popayanense Hieron., Toro 296; Archer H-184.

Eupatorium tacotanum Klatt., Mayor 194; Chardon & Nolla 440.

Eupatorium tequendamense Hieron., Mayor 85.

Eupatorium thyrigerum Hieron., Mayor 234.

Eupatorium sp., Mayor 159; Chardon 140.

The specimens here listed as belonging to *Cronartium praelongum* show considerable variation as to diameter and length of the telial columns and as to size of the spores. The variations in measurements have been set forth both by Mayor (9, pp. 545-546) and in our earlier paper (Jour. Dept. Agr. Puerto Rico 14: 305). We are in doubt as to the significance of such variations. *Cronartium andinum* Lagerh. seems without doubt to be a separate species. We have not seen authentic specimens of *C. eupatorinum* Speg. described from Argentine. This group needs further study. We are regarding *Cionothrix* as a microcyclic form of *Cronartium*.

CROSSOPSORA Sydow, Ann. Myc. 16: 243. 1918.

Crossopsora caucensis (Mayor) comb. nov.

Uredo caucensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 587. 1913.

Cronartium Wilsonianum Arth. Mem. Torrey Club 17: 114. 1918.

Crossopsora Wilsoniana Arth. N. Am. Flora 7: 696. 1925.

On *Cissus rhombifolia* Vahl. (called *Vitis* sp. by Mayor), Mayor 91.

Through the kindness of Dr. Mayor we have had available the entire material of his collection no. 91. A study of the host by Dr. H. A. Gleason and Mr. Percy Wilson of the New York Botanical Garden reveals that it is *Cissus rhombifolia*. We have found present telial columns which make certain the reference to the genus *Crossopsora*. Without seeing Mayor's specimen we erroneously referred *Uredo caucensis* to *Phakopsora Vitis* (Jour. Puerto Rico Dept. Agr. 14: 304. 1930).

DICHEIRINIA Arth. N. Am. Flora 7: 147. 1907.

DICHEIRINIA BINATA (Berk.) Arth. N. Am. Flora 7: 147. 1907.

Uredo Cabreriana Kern & Kellerm. Jour. Myc. 13: 25. 1907.

On *Erythrina glauca* Willd., Toro 181; Chardon & Nolla 320; Mayor 321, 321a.

ENDOPHYLLOIDES Whetz. & Olive, Am. Jour. Bot. 4: 50. 1917.

ENDOPHYLLOIDES PORTORICENSIS Whetz. & Olive, Am. Jour. Bot. 4: 50. 1917.

On *Mikania Guaco* H. & B., *Chardon* 575.

ENDOPHYLLUM Lév. Mem. Soc. Linn. Paris 4: 208. 1825.

ENDOPHYLLUM CIRCUMSCRIPTUM (Schw.) Whetz. & Olive, Am. Jour. Bot. 4: 49. 1917.

Aecidium circumscriptum Schw.; Berk. & Curt. Jour. Phila. Acad. Sci. II. 2: 283. 1853.

Aecidium Cissi Wint. Hedwigia 23: 168. 1884.

Endophyllum guttatum Sydow, Ann. Myc. 18: 179. 1920.

On *Cissus sicyoides* L. (*Vitis sicyoides* (L.) Baker), *Toro* 206, 268; *Chardon* & *Nolla* 275; *Mayor* 305b.

Cissus sp. (*Vitis* sp.), *Mayor* 45 (not seen).

Sydow has pointed out (*Mycologia* 18: 179. 1920) that *Aecidium guttatum* Kuntze (1827) was doubtless applied to this species but the name seems not to have established without doubt by Kuntze in Weigelt's *Exsiccati*.

ENDOPHYLLUM DECOLORATUM (Schw.) Whetz. & Olive, Am. Jour. Bot. 4: 49. 1917.

Aecidium Wedeliae Earle, *Muhlenbergia* 1: 16. 1901.

Aecidium Clibadii Sydow, Ann. Myc. 1: 333. 1903.

On *Clibadium surinamense* L., *Toro* 200, 241; *Chardon* & *Nolla* 532, 701; *Mayor* 106; *Archer* H-171.

Clibadium surinamense asperum (Aublet) Baker, *Mayor* 299a.

Wedelia carnososa Rich., *Mayor* 135.

We have in addition one other collection, *Chardon* 717, previously undetermined as to host or rust, which is without doubt this species on *Clibadium*.

ENDOPHYLLUM STACHYTARPHETAE (P. Henn.) Whetz. & Olive, Am. Jour. Bot. 4: 50. 1917.

Aecidium Stachytarphetae P. Henn. Hedwigia Beibl. 38: 71. 1899.

On *Valerianodes cayennense* (L. C. Rich.) Kuntze, (*Stachytarpheta cayennensis* (Rich.) Vahl.), *Chardon* 560; *Toro* 228, 554; *Mayor* 177a.

KUEHNEOLA Magn. Bot. Centr. 74: 169. 1898.

KUEHNEOLA LOESENERIANA (P. Henn.) Jackson & Hol. Mycologia 23: 105. 1931.

Uredo Loeseneriana P. Henn. Hedwigia 37: 373. 1898.

Spirechina Loeseneriana Arth. Jour. Myc. 13: 30. 1907.

Uromyces Loesenerianus Sydow, Monog. Ured. 2: 202. 1910.
On *Rubus urticifolius* Poir. Mayor 107; Toro 323; Archer H-16.

According to Jackson (Mycologia 23: 105. 1931) the teliospores of this species occur in chains which means that it belongs to the genus *Kuehneola*. Since this species (*Uredo Loeseneriana*) was the type of the genus *Spirechina* that name now becomes a synonym of *Kuehneola*. The several species with teliospores borne singly previously referred to *Spirechina* are now included under *Mainsia*.

MAINSIA Jackson, Mycologia 23: 106. 1931.

This name was proposed by Jackson to replace *Spirechina* when it was found that the type species of the latter belonged to *Kuehneola*. An important difference between the two genera is that *Mainsia* has teliospores borne singly on pedicels whereas *Kuehneola* has them in chains.

Mainsia columbiensis (Kern & Whetz.) comb. nov.

Spirechina columbiensis Kern & Whetz. Jour. Dept. Agr. Puerto Rico 14: 308. 1930.

On *Rubus* sp., Toro 266.

MAINSIA CUNDINAMARCENSIS (Mayor) Jackson, Mycologia 23: 114. 1931.

Spirechina cundinamarcensis Diet. in E. & P. Nat. Pfl. 2nd ed. 6: 60. 1928.

Uromyces cundinamarcensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 452. 1913.

On *Rubus peruvianus* Fritsch, Mayor 105.

MAINSIA LAGERHEIMII (P. Magn.) Jackson & Holw. Mycologia 23: 110. 1931.

Spirechina Lagerheimii Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 309. 1930.

Uromyces Lagerheimii P. Magn. Ber. Deuts. Bot. Ges. 14: 377. 1896.

On *Rubus glaucus* Benth., Mayor 101.

Rubus sp., Mayor 302 (not seen).

MAINSIA MAYORII Jackson, Mycologia 23: 112. 1931.

Spirechina quitensis Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 309. 1930.

Uromyces quitensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 456. 1913. Not Lagerheim 1895.

On *Rubus* sp., Mayor 105a, 322a; Toro 570.

Jackson has provided a name for this species which he says was referred by Mayor to *Uromyces quitensis* Lagerh. in error. For further explanation see Mycologia 23: 112, 113, 115. 1931. Both of the Mayor specimens examined by us, and the Toro specimen, have only uredinia present. Both sori and spores agree perfectly with Mayor's account. We find the walls of the uredospores to be thicker than indicated in Jackson's paper.

MAINSIA RUBI-URTICIFOLII (Mayor) Jackson, Mycologia 23: 115. 1931.

Spirechina Rubi-urticifolii Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 309. 1930.

Uromyces Rubi-urticifolii Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 454. 1913.

On *Rubus adenotrichos* Schlecht. Tranvia de Oriente, 22 Km. north of Medellin, Feb. 7, 1931, Archer H-233.

Rubus urticifolius Poir., Mayor 300.

Rubus sp., Toro 270.

Apparently a microcyclic species.

MAINSIA VARIABILIS (Mayor) Jackson & Holw. Mycologia 23: 111. 1931.

Spirechina variabilis Diet. in E. & P. Nat. Pfl. 2nd ed. 6: 60. 1928.

Uromyces variabilis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 457. 1913.

On *Rubus* sp., Chardon & Nolla 610; Mayor 301 (not seen).

MILESINA BLECHNI Sydow. See *Milesia australis* Arth.

MILESINA DENNSTAETIAE Mayor. See *Milesia Dennstaedtia* (Mayor) Faull.

MILESINA COLUMBIENSIS Diet. See *Milesia columbiensis* (Diet.) Arth.

MILESIA F. B. White, in Scot. Nat. 4: 162. 1877.

MILESIA AUSTRALIS Arth. Bull. Torrey Club 51: 53. 1924.

On *Blechnum occidentale* L., Mayor 182c.

In the Mayor paper (Mem. Soc. Neuch. Sci. Nat. 5: 559) Dietel referred this rust on *Blechnum* to *Milesina Blechni* Sydow. Faull in his recent monograph (Contr. Arnold Arboretum of Harvard University II, 41. 1932) refers this Colombian species to *Milesia australis*, and makes the Mayor collection no. 182c the type of *Milesia australis* forma *irregularis* Faull.

MILESIA COLUMBIENSIS (Diet.) Arth. Mycologia 7: 175. 1915.

Milesina columbiensis Diet.; Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 559. 1913.

On *Nephrolepis pendula* Raddi., Mayor 151 (not seen).

For revised description of this species see Faull (Contr. Arnold Arboretum Harvard University II, 75. 1932).

MILESIA DENNSTAEDTIAE (Diet.) Toro, Rev. Soc. Colomb. Ci. Nat. 18: 43. 1929.

Milesina Dennstaedtia Diet.; Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 558. 1913.

On *Dennstaedtia rubiginosa* (Kaulf.) Moore, Mayor 184.

PHAKOPSORA Diet. Ber. Deuts. Bot. Ges. 13: 334. 1895.

PHAKOPSORA (?) AESCHYNOMENIS Arth. Bull. Torrey Club 44: 509. 1917.

Uredo Aeschynomenis Arth. Bot. Gaz. 39: 392. 1905.

On *Aeschynomene americana* L., Mayor 153a.

Aeschynomene sensitiva Sw., Mayor 153.

The telia of this species are yet unknown and it is not possible to refer it to the proper genus without doubt. We are following Arthur in referring it to the genus *Phakopsora*.

PHAKOPSORA COLUMBIANA Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 304. 1930.

On *Croton gossypifolius* Vahl., Chardon 552b, 555.

Several authors have recognized the genus *Bubakia* which differs from *Phakopsora* in having neither peridium nor paraphyses in the uredinia. If *Bubakia* were to be maintained this species along with several others on the host *Croton* would be referred to that genus.

PHAKOPSORA VIGNAE (Bres.) Arth. Bull. Torrey Club 44: 509. 1917.

Uredo Teramni Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 587. 1913.

Uredo concors Arth. Mycologia 7: 330. 1915.

On *Teramnus uncinatus* (L.) Sw., Mayor 274.

The characters given by Mayor in the original description of *Uredo Teramni* did not indicate its relation to the North American rust on this host (*Uredo concors* Arth.) and such a probability was rejected by Arthur (Mycologia 7: 331. 1915) and again by us (Jour. Dept. Agr. Puerto Rico 14: 346. 1930). Examination of the type specimen, however, clearly proves its identity. The type has the characteristic sorus opening by a central pore and the typical paraphyses are present. Arthur has assigned this uredo-form to the genus *Phakopsora* but the absence of telia on all specimens does not admit such a reference without some doubt.

PHAKOPSORA VITIS (Thüm.) Sydow, Hedwigia 38: 141. 1899. On *Vitis* sp., Chardon & Nolla 479.

For *Uredo caucensis* Mayor, which was included here as a synonym (Jour. Dept. Agri. Puerto Rico 14: 304. 1930) see *Crossopora caucensis*.

PHRAGMIDIUM Link, Ges. Nat. Freunde Berlin Mag. 7: 30. 1815.

PHRAGMIDIUM DISCIFLORUM (Tode) James, Contr. U. S. Nat. Herb. 3: 276. 1895.

On *Rosa* sp. (cultivated), Toro 413; Mayor 7 (not seen).

PROSPODIUM Arth. Jour. Myc. 13: 31. 1907.

PROSPODIUM APPENDICULATUM (Wint.) Arth. See *Prospodium Von Gunteni* (Mayor) Kern & Whetz.

PROSPODIUM VON GUNTENI (Mayor) Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 310. 1930.

Puccinia Von Gunteni Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 490. 1913.

On *Lippia americana* L., Mayor 368.

Lippia sp., Baker 93.

Through the kindness of Dr. Samuelsson, of Stockholm, we have had a part of the Baker collection for study. Dietel (Bull. Torrey Club 26: 632. 1899) studied this specimen. He thought it was on some Bignoniaceae and remarked that although the appendages on the teliospore pedicels were poorly developed or wanting he did not doubt its determination as *Puccinia appendiculata*. A note on the original says "on a shrubby herb—one of the Myrsinaceae?" Our examination of the rust shows that the teliospores have one whorl of appendages and that both teliospores and uredospores agree with *Prospodium Von Gunteni*. A detailed study of the fragmentary specimen also shows that the veining, margin, and pubescence of the leaf are so nearly identical with those of Mayor's no. 368 that there seems no doubt about the possibility of its being a species of *Lippia*.

PUCCINIA Link, in Willd. Sp. Pl. 6²: 67. 1825.

PUCCINIA ABREPTA Kern, Mycologia 11: 140. 1919.

On *Cyperus* sp., Chardon 115, 707.

PUCCINIA ALBIDA Diet. & Meg. See *Puccinia pallidissima* Speg.

PUCCINIA ANCIZARI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 525. 1913.

On *Baccharis nitida* Pers., Mayor 65, 170a.

The number 170a was used also under *Puccinia Mayerhansi*, p. 521, by Mayor.

PUCCINIA ANODAE Sydow, Monog. Ured. 1: 475. 1903.

On *Anoda cristata* (L.) Schlecht., Killip (phan. spec.) no. 6200.

Anoda hastata Cav., Mayor 90, 218.

A microcyclic species. Mayor's no. 90 listed by him as *Puccinia heterospora* belongs here.

PUCCINIA ANTIOQUIENSIS Mayor. See *Puccinia subcoronata* P. Henn.

PUCCINIA APPENDICULATA Wint. See *Prospodium Von Gunteni* (Mayor) Kern & Whetz.

PUCCINIA ARECHAVELATAE Speg. Anal. Soc. Ci. Argent. 12: 67. 1881.

On *Cardiospermum* sp., Toro 552.

Serjania (?) *brevipes* Benth., Chardon & Nolla 428.

Serjania membranacea Splitg., Chardon & Nolla 423.

Serjania sp., Mayor 318.

Sapindaceae sp., Mayor 317, 319, 320.

A microcyclic species.

PUCCINIA ASTERIS Duby, Bot. Gall. 2: 888. 1830.

Puccinia Doloris Speg. Anal. Soc. Ci. Argent. 12: 23. 1881.

On *Erigeron* cf. *uliginosus* Benth., Mayor 229.

PUCCINIA ATRA Diet. & Holw. Bot. Gaz. 24: 29. 1897.

On *Paspalum prostratum* Scrib. & Merr., Chardon 663, 665.

PUCCINIA BACCHARIDIS-RHEXIOIDES Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 517. 1913.

On *Baccharis rhexioides* H.B.K., Chardon & Nolla 273; Chardon 546; Mayor 199.

PUCCINIA BALLOTAEFLORAE Long, Bull. Torrey Club 29: 116. 1902.

Uredo Salviarum Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 592. 1913.

On *Salvia cataractarum* Briq., Mayor 49.

Salvia Mayorii Briq., Mayor 47.

Salvia petiolaris H.B.K., Mayor 203.

Arthur (N. Am. Flora 7: 411. 1921) placed *Uredo Salviarum* Mayor as a synonym of *Puccinia salviicola* Diet. & Holw. On the basis of Mayor's description, this seemed correct and was followed in our paper on Colombian rusts (Jour. Dept. Agric. Puerto Rico 14: 334. 1930). Examination of Mayor's specimens here listed convinces us that this is an error. We find these specimens to have 3-4 pores, 2 slightly below the equator, and 1 or 2 apical. This is a peculiar arrangement and agrees with Long's *P. Ballotae-florae*. With only uredospore size, color, and wall characters it

would be impossible to separate *P. salviicola* and *P. Ballotaeflorae*. The pore characters would seem to leave no doubt.

PUCCINIA BARRANQUILLAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 533. 1913.

On *Spilanthes urens* Jacq., Mayor 127.

A microcyclic form closely related to *Puccinia Melampodii*.

PUCCINIA BECKI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 509. 1913.

On *Vernonia Cotoneaster* (Willd.) Less., Mayor 32.

PUCCINIA BIMBERGI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 530. 1913.

Aecidium Heliopsidis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 573. 1913.

On *Heliopsis buphthalmoides* (Jacq.) Dunal, Toro 289, 320; Chardon 713; Mayor 239, 239a.

Mayor has already pointed out the possible relation of these two forms. One of the Toro collections, no. 320, bears both aecia and telia in such a manner as to suggest relationship. Further evidence comes from the North American species, *Puccinia Batesiana* Arth. on *Heliopsis*, which has a life cycle with aecia and telia without a uredo stage. The South American form resembles *P. Batesiana* in most respects but for the present it seems best to consider the two as parallel and closely related species.

PUCCINIA BOCCONIAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 478. 1913.

On *Bocconia frutescens* L., Mayor 202.

A microcyclic species.

PUCCINIA BOGOTENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 480. 1913.

On *Geranium multiceps* Turcz., Mayor 364 (not seen).

A microcyclic species with large teliospores ($18-24 \times 65-87 \mu$).

PUCCINIA BOMAREAE (Lagerh.) P. Henn. Hedwigia 35: 342. 1896.

Uredo Bomareae Lagerh. in Pat. & Lagerh. Bull. Soc. Myc. Fr. 11: 215. 1895.

Accidium Bomareae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 559. 1913.

On *Bomarea* cf. *Caldasii* (H.B.K.) Willd., Mayor 13.

Bomarea potacocensis Herb., Mayor 14 (specimen not seen).

Examination of Mayor's specimen no. 13 convinces us that it is a *Uredo* rather than an *Accidium*. The spore characters agree sufficiently well to warrant the disposition here made. The species is known also from Ecuador and Brazil.

PUCCINIA BOMBACIS Diet.; Earle, Bull. Torrey Club 26: 632. 1899.

On *Bombax* sp., Baker 80.

Through the kindness of Mr. G. Samuelsson, Director of the Botany Department, Naturhistoriska Riksmuseet, Stockholm, we have been able to examine the type specimen.

PUCCINIA CAEOMATIFORMIS Lagerh.; Sydow, Monog. Ured. 1: 24. 1902.

On *Baccharis floribunda* H.B.K., Chardon 599, 644.

Baccharis polyantha H.B.K., Mayor 99.

PUCCINIA CALEAE Arth. Bot. Gaz. 40: 201. 1905.

Uredo Caleae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 598. 1913.

On *Calea glomerata* Klatt., Mayor 195.

Examination of specimens from Mexico and Brazil referred to *Puccinia Caleae* Arth. convince us that there is no difference between the uredo stage of that species and *Uredo Caleae* Mayor.

PUCCINIA CAMELIAE (Mayor) Arth. Mycologia 7: 227. 1915.

Uredo Cameliae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 578. 1913.

On *Chaetochloa scandens* (Schrad.) Scribn. & Merr. (*Setaria scandens* Schrad.), Mayor 257.

PUCCINIA CANALICULATA (Schw.) Lagerh. Tromsø Mus. Aarsh. 17: 51. 1894.

On *Cyperus ferax* L. C. Rich., Chardon & Nolla 220.

PUCCINIA CANNAE (Wint.) P. Henn. Hedwigia 41: 105. 1902.

On *Canna coccinea* Miller., Mayor 196a.

Canna sp., Chardon 712.

PUCCINIA CAPSICI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 501.
1913.

On *Capsicum* cf. *baccatum* L., Mayor 84.

A microcyclic form.

PUCCINIA CENCHRI Diet. & Holw.; Holw. Bot. Gaz. 24: 28.
1897.

On *Cenchrus echinatus* L., Chardon & Nolla 430; Chardon 169;
Mayor 154.

Pennisetum bambusiforme (Tourn.) Hemsl., Toro 276.

PUCCINIA CHAETOCLOAE Arth. Bull. Torrey Club 34: 585.
1907.

On *Paspalum macrophyllum* H.B.K., Chardon & Nolla 287.

PUCCINIA CHASEANUM Arth. & Fromme, Torreyana 15: 264. 1915.

On *Antheophora hermaphrodita* (L.) Kuntze, Virginias, Jan. 12,
1931, Archer H-207.

Both uredinia and telia are present. The spores agree very well with the description of *Puccinia Chaseanum*. Paraphyses are present and are inclined to be somewhat capitate rather than hyphoid as described but this does not seem to us an important variation. We do not find that this species has been reported previously from South America; it is known from the West Indies and Central America.

PUCCINIA CLAVIFORMIS Lagerh. Tromsö Mus. Aarch. 17: 53.
1895.

Puccinia huallagensis P. Henn. Hedwigia 43: 158. 1904.

Puccinia solanicola Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 505.
1913.

Puccinia solanita Arth. Mycologia 14: 19. 1922.

On *Solanum hirtum* Vahl., Mayor 3.

Solanum aff. *myrianthum* Britt., Toro 403.

Solanum aff. *ovalifolium* H. & B., Mayor 46.

Solanum stramonifolium Jacq., Toro 183.

Solanum torvum Sw., Chardon 570; Chardon & Nolla 274;

Archer H-12; Toro 187.

Solanum aff. *torvum* Sw., Mayor 190.

Solanum sp., Chardon 10; Chardon & Nolla 339, 357; Baker
76; Mayor 98.

Our investigations of the microcyclic rusts on *Solanum* convince us that the name *Puccinia solanita* as used in our former paper (Jour. Dept. Agric. Puerto Rico 14: 335) is not a tenable name having been founded on *Aecidium solanatum* Schw. which was a hyponym. Lagerheim proposed *P. claviformis* for this species and it seems to be the acceptable name. *P. Solani* Schw. taken up by Arthur (N. Am. Flora 7: 805. 1927) for this species is a different thing. We believe *P. solanicola* Mayor is a synonym of *P. claviformis*. We are referring all the collections determined by Mayor as *P. huallagensis* to *P. claviformis*. For discussion of this and related microcyclic forms on *Solanum* see Kern (Mycologia 25: 435-441. 1933).

PUCCINIA CLEMATIDIS (DC.) Lagerh. Tromsø Mus. Aarsh. 17: 54. 1895.

On *Bromus unioloides* H.B.K., Chardon 647.

Triticum aestivum L., Chardon & Nolla 445; Archer H-67, H-229; Chardon 760.

PUCCINIA CONOCLINII Seym.; Burrill, Bot. Gaz. 9: 191. 1884.
Uredo Agerati Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 595. 1913.

On *Ageratum conyzoides* L., Chardon 714; Mayor 217; Archer H-62, H-144.

Ageratum conyzoides L. var. *inaequipaleaceum* Hieron., Mayor 53.

The collections on *Eupatorium* which were included under this species (Jour. Dept. Agric. Puerto Rico 14: 321. 1930) are now listed under *Uredo Eupatorium* Mayor.

(?) PUCCINIA CONTURBATA Jackson & Holw. Mycologia 24: 75. 1932.

On *Salvia palaefolia* H.B.K., LaSierra, 18 km. north of Medellin, Dec. 26, 1930, II, Archer H-186.

With the numerous rusts on *Salvia* it is difficult, if not impossible, to be certain of a determination when only uredinia are present. This specimen fits the description of *Puccinia conturbata* but we do not feel it can be so referred without doubt.

PUCCINIA CONVULVACEARUM Mayor. See *Puccinia Spegazzinii* De-Toni.

PUCCINIA CRASSIPES Berk. & Curt., *Grevillea* 3: 54. 1874.

Puccinia Ipomoeae-panduratae Sydow, *Monog. Ured.* 1: 323. 1902.

On *Ipomoea* aff. *caloneura* Meiss., *Mayor* 289.

Ipomoea sp., *Toro* 405; *Chardon* 121; *Mayor* 287b.

PUCCINIA CUNDINAMARCENSIS Mayor. See *Puccinia ferox* Diet. & Holw.

PUCCINIA CYNODONTIS Lacroix, in Desmaz. *Pl. Crypt.* II. 655. 1859.

On *Capriola Dactylon* (L.) Kuntze, *Toro* 184; *Archer H*-124.

PUCCINIA CYPERI Arth. *Bot. Gaz.* 16: 226. 1891.

Aecidium Erigerontis Kern & Whetz. *Jour. Dept. Agr. Puerto Rico* 14: 342. 1930.

On *Erigeron bonariensis* (L.) Small, *Chardon & Nolla* 424.

Cyperus caracasanus Kunth, *Chardon & Nolla* 312.

Cyperus globulosus Aubl., *Chardon & Nolla* 230.

Dr. J. J. Davis, in Wisconsin, has proved by cultures that *Puccinia Cyperi* develops its acial stage on *Erigeron* (*Trans. Wis. Acad. Sci.* 27: 187. 1932). He states that the aeciospores on *Erigeron* have walls thicker above. We believe that *Aecidium Erigerontis* described by us from Colombia is identical with the form connected by Dr. Davis to *Puccinia Cyperi*. These aeciospores differ from those belonging to *Puccinia Asterum*, also on *Erigeron*, in their larger size as well as in the thickening in the upper part of the wall. Without doubt many specimens in herbaria on *Erigeron* labelled as *Puccinia Asterum* will be found to belong to *Puccinia Cyperi*.

PUCCINIA DICHROMENAE (Arth.) Jackson, *Trans. Brit. Myc. Soc.* 13: 16. 1928.

Uredo Dichromenae Arth. *Bull. Torrey Club* 33: 31. 1906.

On *Dichromena ciliata* Vahl., *Chardon* 725.

Dichromena polystachys Turrit, *Mayor* 282.

Dichromena radicans Cham. & Schlecht., *Mayor* 281.

Dichromena sp., *Chardon* 566.

PUCCINIA DOLORIS Speg. See *Puccinia Asteris* Duby.

PUCCINIA DUBIA Mayor. See *Puccinia Spegazzinii* De-Toni.

PUCCINIA ELEUTHERANTHERAE Diet. See *Puccinia Melampodii* Diet. & Holw.

PUCCINIA EPIPHYLLA (L.) Wettst. Verh. Zool.-Bot. Ges. Wein 35: 541.

Puccinia Poarum Niels. Bot. Tidsskr. III. 2: 34. 1877.

On POA ANNUA L., *Chardon* 628; *Toro* 410.

Poa pratensis Nielson, *Chardon* 616, 631.

Jørstad (Nyt. Mag. Naturv. 70: 325-408. 1932) believes, as a result of his studies on European material that the name for this rust should be *Puccinia Poae-sudeticae* (Westend.) Jørstad. *Puccinia eragrostidicola* sp. nov.

Uredosoris amphigenis, sparsis, ellipticis vel oblongis, parvis, 0.2 mm.-longis, quandoque confluentibus, tarde nudis, epidermide rupta visibili; paraphysibus plerumque clavatis, subincurvatis, $7-13 \times 32-42 \mu$, membrana levi, $1-1.5 \mu$ cr., hyalina; uredosporis late ellipsoideis vel obovoideis, $13-18 \times 19-25 \mu$; membrana hyalina vel subhyalina, $1.5-2 \mu$ cr., minute verrucoso-echinulata; poris obscuris.

Teleutosoris amphigenis, sparsis, oblongis vel linearibus, 0.4-0.8 mm. longis, mox nudis, atro-brunneis, epidermide rupta non visibili; teliosporis late ellipsoideis, $23-27 \times 29-35 \mu$, septo non constrictis; membrana castaneo-brunnea, $2.5-3 \mu$ cr., apice leniter incrassata ad $4-6 \mu$, levi; pedicello tincto, $5-6 \mu$ lato, sporam aequante vel longiore, saepe oblique inserto.

On *Eragrostis inconstans* Nees, Quebrada de la Garcia, June 29, 1930, *Archer H-69*.

The genus *Eragrostis* seems to be rather free from rusts. In North America only *Uromyces Eragrostidis* is known. Arthur in his study of the grass rusts of South America (Proc. Am. Phil. Soc. 64: 210. 1925) has reported only *U. Eragrostidis*. There is one *Puccinia* on this host-genus described from Ceylon by Petch and named *Puccinia Eragrostidis*. The teliospores in the Asiatic species are so much smaller, especially narrower ($15-17 \times 20-32 \mu$), that there seems little doubt as to the difference between it and our species.

PUCCINIA EUPATORII Diet. See *Uredo Eupatoriorum* Mayor.

PUCCINIA EUPATORIICOLA Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 513. 1913.

On *Eupatorium pycnocephalum* Less., *Mayor* 44.

Eupatorium Schiedeana Less., *Mayor* 228.

A microcyclic species.

PUCCINIA EUPATORII-COLUMBIANI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 514. 1913.

On *Eupatorium columbianum* Heering, Mayor 298.

PUCCINIA EVADENS Harkn. Bull. Calif. Acad. 1: 34. 1884.

On *Baccharis cassinaefolia* DC., Chardon 64.

PUCCINIA FEROX Diet. & Holw.; Holw. Bot. Gaz. 31: 333. 1901.

Puccinia cundinamarcensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 536. 1913.

On *Verbesina* (?) *nudipes* Blake, Chardon & Nolla 480; Mayor 69.

Verbesina verbascifolia Walp., Mayor 40.

Verbesina sp., Chardon & Nolla 449.

Our studies lead us to consider *P. cundinamarcensis* a synonym of *P. ferox*. One of the chief differences was supposed to be in the walls of the spores. Mayor described his specimen as having smooth walls and *P. ferox* is said to appear smooth when wet but to be finely verrucose rugose. We find Mayor's specimen actually not smooth and we think the roughness of *P. ferox* over emphasized. *P. examinata* Jackson & Holw. differs in the thicker walls of the teliospores and in having the pore in the lower cell always close to the hilum.

PUCCINIA FILOPES Arth. & Holw. Mycologia 10: 131. 1918.

On *Buettneria carthaginensis* Jacq., Chardon & Nolla 382.

PUCCINIA FIMBRISTYLIDIS Arth. Bull. Torrey Club 33: 28. 1906.

On *Fimbristylis annua* (All.) R. & S., Mayor 258.

PUCCINIA FUHRMANNI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 507. 1913.

On *Justicia* cf. *secunda* Vahl. cf. var. *intermedia* (Nees) Thellung, Mayor 62.

PUCCINIA GLUMARUM (Schm.) Erikss. & Henn. Zeits. Pflanzenkr. 4: 197. 1894.

On *Triticum aestivum* L. (var. Kota), Chardon 635.

PUCCINIA GONZALEZI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 502. 1913.

On *Capsicum* sp., Mayor 365.

A microcyclic species.

PUCCINIA GOUANIAE Holw. Ann. Myc. 3: 21. 1905.

On *Gouania* sp., *Toro* 293.

PUCCINIA HETEROSPORA Berk. & Curt.; Berk. Jour. Linn. Soc. 10: 356. 1869.

On *Abutilon umbellatum* (L.) Sweet, *Mayor* 27.

Anoda hastata Cav., *Toro* 195.

Bastardia viscosa (L.) H.B.K., *Mayor* 15.

Malvastrum peruvianum (L.) A. Gray, *Toro* 409.

Sida rhombifolia L., *Chardon* 549.

Sida spinosa L., *Chardon & Nolla* 283; *Chardon* 30.

Wissadula periplocifolia (L.) Presl., *Mayor* 16 (not seen).

Malvaceae sp., *Chardon & Nolla* 325, 395; *Mayor* 76, 314.

PUCCINIA HUALLAGENSIS P. Henn. See *Puccinia claviformis* Lagerh.

PUCCINIA HYDROCOTYLES (Link) Cooke, *Grevillea* 9: 14. 1880.

On *Hydrocotyle leucocephala* Cham., *Mayor* 94.

Hydrocotyle quinqueloba Ruiz & Pav. var. *stella* (Pohl.)

Urban, *Mayor* 61 (no rust on our specimen).

Hydrocotyle umbellata L., *Toro* 249; *Mayor* 179.

PUCCINIA HYPTIDIS Tracy & Earle, Bull. Miss. Agr. Exp. Sta. 34: 86. 1895.

On *Hyptis capitata* Jacq. var. *vulgaris* Briq., *Mayor* 224.

PUCCINIA HYPTIDIS-MUTABILIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 496. 1913.

On *Hyptis mutabilis* (Rich.) Briq. var. *polystachya* H.B.K., *Mayor* 294.

Hyptis mutabilis (Rich.) Briq. var. *spicata* (Poir.) Briq., *Mayor* 121.

PUCCINIA IMPEDITA Mains & Holw.; Arth. Mycologia 10: 135. 1918.

On *Salvia petiolaris* H.B.K., *Toro* 295.

PUCCINIA IPOMOEAE-PANDURATAE Sydow. See *Puccinia cras-sipes* Berk. & Curt.

PUCCINIA LANTANAE Farl. Proc. Am. Acad. 18: 83. 1883.

On *Lantana camara* L., *Toro* 180.

Lantana hispida H.B.K., *Mayor* 212.

Lantana tiliifolia Cham., Mayor 28.

Lantana trifolia L., Mayor 214a.

PUCCINIA LATERITIA Berk. & Curt. Jour. Phila. Acad. Sci. 2: 281. 1853.

On *Borreria laevis* (Lam.) Griseb., Toro 194, 376; Chardon & Nolla 327; Mayor 263.

Borreria latifolia (Aubl.) Schum., Chardon 548, 567, 587, 721.

Diodia cymosa Cham., Tranvia del Oriente, 22 km. north of Medellin, Feb. 7, 1931, Archer H-227.

PUCCINIA LEONOTIDIS (P. Henn.) Arth. Mycologia 7: 245. 1915.

Puccinia leonotidicola P. Henn. in H. Baum, Kun. Samb. Exp. 2. 1903.

On *Leonotis nepetaefolia* (L.) R. Br., Chardon 554, 592; Chardon & Nolla 263, 359; Toro 558.

PUCCINIA LEVIS (Sacc. & Bizz.) Magn. Ber. Deuts. Bot. Ges. 9: 190. 1891.

Puccinia Paspali Tracy & Earle, Bull. Torrey Club 22: 174. 1895.

On *Axonopus scoparius* (Fl.) Hitch., Chardon 72; Archer H-76.
Paspalum Fournierianum Ricker var. *maximum* Thellung, Mayor 163.

Paspalum pilosum Lam., Chardon 75.

Rytilix granularis (L.) Skeels (*Manisuris* Sw., *Hackelochloa* Kuntze), Archer H-82.

PUCCINIA LIABI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 539. 1913.

On *Liabum hastatum* (Wedd.) Britton, Mayor 171.

A microcyclic species. Reported also from Ecuador and Belvia by Jackson (Mycologia 24: 179. 1932).

PUCCINIA LITHOSPERMI Ellis & Kellerm. Jour. Myc. 1: 2. 1885.

On *Evolvulus villosus* Ruiz & Pav., Bello, June 19, 1930, Archer H-59.

This South American form agrees with the North American one described as *Puccinia Lithospermi*. Whether it should be regarded as a synonym of *Puccinia tuyatensis* according to Arthur

(N. Am. Flora 7: 791) is a question which we cannot decide on account of a lack of authentic specimens for comparison.

***Puccinia Lucumae* sp. nov.**

Uredosoris hypophyllis, sparsis, rotundatis, 0.2–0.5 mm. diam., pallide cinnamomeo-brunneis, mox nudis; epidermide rupta visibili; uredosporis globosis, late ellipsoideis vel obovoideis, $29\text{--}35 \times 35\text{--}40 \mu$; membrana flavida vel brunneolo-flava, $3\text{--}5 \mu$ cr., basi interdum tenuescenti, sparse valdeque echinulata, circa pedicellum levi; poris 2 vel 3, aequatorialibus.

Teleutosoris hypophyllis, sparsis, rotundatis vel ellipticis, 0.2–0.7 mm. diam., pallide castaneo-brunneis, epidermide rupta non visibili; teleutosporis late ellipsoideis, $27\text{--}32 \times 35\text{--}45 \mu$, supra et infra rotundatis, cellula inferiore plerumque minore, septo non vel leniter constrictis; membrana aurato-brunnea, infra 1.5μ cr., levi, supra incrassata ad $4\text{--}5 \mu$, minute verrucosa; pedicello subhyalino, sporam aequante vel brevior.

On *Lucuma* sp., Cafetal La Suiza, near Titiribi, Aug. 31, 1930,
Archer H-100.

We do not find a *Puccinia* described on this host genus. There is a uredo form, *Uredo Lucumae*, which differs markedly in having a wall of two layers. There is a *Uromyces Lucumae* in Brazil but the urediniospores of it do not possess characters indicative of any correlation.

PUCCINIA MACROPODA Speg. See *Puccinia striolata* (Speg.)
Arth.

PUCCINIA MALVACEARUM Bertero; Mont. in C. Gay, Fl. Chile 8:
43. 1852.

Puccinia Sidae-rhombifoliae Mayor, Mem. Soc. Neuch. Sci.
Nat. 5: 484. 1913.

On *Malvastrum corchorifolium* (Desr.) Britton, Chardon 589.

Malvastrum coromandelianum (L.) Garcke, Toro 177, 186;
Chardon & Nolla 251, 321; Chardon 583; Mayor 240e.

Malvastrum tricuspidatum A. Gray (*M. americanum* Torr.),
Chardon & Nolla 389.

Malvastrum sp., Chardon & Nolla 335.

Sida rhombifolia L., Mayor 241.

PUCCINIA MARISCI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 474.
1913.

On *Mariscus flavus* Vahl., Mayor 283.

Mariscus hermaphroditus (Jacq.) Urban, Mayor 278.

Puccinia MAYERHANSI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 521. 1913.

On *Baccharis oronocensis* DC., Toro 291; Mayor 170.

The number 170 was used also under *Puccinia Ancizari*.

Puccinia MAYDIS Bereng. See *Puccinia Sorghi* Schw.

Puccinia MEDELLINENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 497. 1913.

On *Hyptis pectinata* (L.) Poir., Toro 271; Mayor 295.

Puccinia MELAMPODII Diet. & Holw. Bot. Gaz. 24: 32. 1897.

Puccinia Synedrellae P. Henn. Hedwigia 37: 277. 1898.

Puccinia Eleutherantherae Diet. Ann. Myc. 7: 354. 1909.

Puccinia Wedeliae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 528. 1913.

On *Eleutheranthera ruderalis* (Sw.) Sch.-Bip., Mayor 132; Toro 239; Chardon & Nolla 292, 332.

Synedrella nodiflora (L.) Gaertn., Chardon 96; Chardon & Nolla 323, 492; Mayor 102a.

Wedelia caracasana DC., Chardon 27.

Wedelia Trichostephia DC., Mayor 237.

The microcyclic rusts on the closely related hosts, *Eleutheranthera*, *Synedrella*, and *Wedelia*, present a difficult problem. They have been described as separate species by as many workers. We have searched in vain for structural characters to separate them satisfactorily and are here following Arthur in the North American Flora where he has included them under *Puccinia Melampodii*. *Puccinia Baranquillae* and *P. spilanthisicola* on *Spilanthes* and *Puccinia tolimensis* on *Eupatorium* are also very similar to the composite species *P. Melampodii* but we are maintaining them as separate species.

Puccinia MENTHAE Pers. Syn. Fung. 227. 1801.

On *Hyptis mutabilis spicata* (Poit.) Epl., Chardon 643, 643b.

Puccinia MONTROYAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 523. 1913.

On *Baccharis floribunda* H.B.K., Mayor 18.

Puccinia MONTERRATES Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 520. 1913.

On *Baccharis bogotensis* H.B.K., Mayor 56.

PUCCINIA NARIÑENSIS Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 330. 1930.

On *Eupatorium* sp., Toro 557.

PUCCINIA OBLIQUA Berk. & Curt.; Berk. Jour. Linn. Soc. 10: 356. 1869.

On *Exolobus* sp., Fredonia, Aug. 2, 1930, Archer H-88.

This appears to be the first report of this microcyclic rust on the genus *Exolobus* but it is known on several closely related genera of the family. This rust appears to be common in South America, as well as in Central America, the West Indies, and southern North America.

PUCCINIA ORTIZI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 503. 1913.

On *Brachistus* aff. *hebeophyllus* Miers., Mayor 25.

A microcyclic species.

PUCCINIA OXALIDIS (Lév.) Diet. & Ellis; Diet. Hedwigia 34: 291. 1895.

Uredo Oxalidis Lév. Ann. Sci. Nat. II. 16: 240. 1841.

Trichobasis Oxalidis Lév. Ann. Sci. Nat. IV. 20: 299. 1863.

On *Oxalis pubescens* H.B.K., Toro 192; reported by Lévillé.

Oxalis sp., Chardon & Nolla 442.

This appears to be the first rust ever reported from Colombia. It is listed by Lévillé in the Prodrômus Florae Novo Granatensis Cryptogamie which was published in 1863.

PUCCINIA OYEDAEAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 535. 1913.

On *Oyedaea* aff. *bupthalmoides* DC., Mayor 150.

Mayor interpreted this species as a *Lepto-Puccinia*. Arthur (N. Am. Flora 7: 431) has transferred this specific name to *Dicaeoma* and described pycnia, aecia, uredinia, and telia. Sydow has transferred the name to *Eriosporangium* (Ann. Myc. 20: 122). According to Jackson both Arthur and Sydow are in error and the proper name for their Costa Rican specimens is *Puccinia Holzwayula*. Jackson (Mycologia 24: 161, 163. 1932) has found uredospores in Mayor's type which he describes as depressed globoid, 18-21 μ in diameter, with 5-6 pores which are sub-equatorial appearing sometimes scattered. Jackson gives a Key

for distinguishing this species from *P. boliviana* and *P. Holwayula*, the only other rusts on *Oyedaea* sp.

PUCCINIA PALLESCENS Arth. Bull. Torrey Club 46: 111. 1919.
On *Zea Mays* L., Chardon & Nolla 337, 509; Chardon 109.

PUCCINIA PALLIDISSIMA Speg. Anal. Soc. Ci. Argent. 12: 69.
1881.

Puccinia albida Diet. & Neg. Bot. Jahrb. 24: 160. 1897.
On *Stachys Mayorii* Briq., Mayor 166.

PUCCINIA PARAMENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5:
493. 1913.

On *Salvia cernua* H.B.K., Mayor 83.

Mayor thought this to be a *Micro-puccinia* but we find numerous urediniospores. They are globoid, 19–24 μ , wall thin, about 1 μ , pale cinnamon brown, finely echinulate, pores obscure. *Puccinia sana* Jackson & Holw. on *Salvia leucocephala* from Ecuador is similar but it seems to us to be distinct.

PUCCINIA PASPALI Tracy & Earle. See *Puccinia levis* (Sacc. & Bizz.) Magn.

PUCCINIA PITTIERIANA P. Henn. Hedwigia 43: 147. 1904.
On *Solanum tuberosum* L., Sacco 537 (com. Toro).

PUCCINIA POCULIFORMIS (Jacq.) Wettst. Verh. Zool.-Bot. Ges.
Wien. 35: 544. 1886.

Puccinia graminis Pers. Neues Mag. Bot. 1: 119. 1794.
On *Agrostis perennans* (Walt.) Tuckerm., Chardon 66.

Anthoxanthum odoratum L., Chardon 660, 664.

Avena sativa L., Chardon 632.

Phleum pratense L., Chardon 634.

Stipa Neesiana Trin. & Rupr., Chardon 619.

Triticum aestivum L., Chardon 622; Diaz 400.

PUCCINIA POLYGONI-AMPHIBII Pers. Syn. Fung. 227. 1801.
On *Persicaria hydropiperoides* (Michx.) Small, Chardon 662.

Persicaria persicarioides (H.B.K.) Small, Chardon 595.

Persicaria punctata (Ell.) Small (*Polygonum acre* H.B.K.),
Chardon 32, 608; Toro 243; Mayor 168.

PUCCINIA PRUNI-SPINOSAE Pers. See *Tranzschelia punctata*
(Pers.) Arth.

PUCCINIA PSIDII Wint. Hedwigia 23: 171. 1884.

Uredo Myrciae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 590
1913.

On *Jambos Jambos* (L.) Millsp., *Toro* 300; *Chardon* 18, 45;
Archer H-156.

Myrcia cf. *acuminata* (H.B.K.) DC., *Mayor* 209.

Myrcia sp., *Toro* 306; *Mayor* 209a.

Psidium sp., *Toro* 308.

Myrtaceae, *Toro* 196, 290, 245, 374.

PUCCINIA PUNCTATA Link, Ges. Nat. Freunde Berlin Mag. 7: 30.
1815.

On *Relbunium hypocarpium* (L.) Hemsley, *Mayor* 262b; *Archer*
H-53.

PUCCINIA PURPUREA Cooke, Grevillea 5: 15. 1876.

On *Holcus Sorghum* L., *Chardon & Nolla* 338.

PUCCINIA PUTA Jackson & Holw. in lit.

Aecidium distinguendum Sydow, Monog. Ured. 4: 131. 1923.

Puccinia distinguenda Jackson & Holw. Mycologia 23: 497.

1931. Not *Puccinia distinguenda* Sydow. 1908.

On *Ipomoea carnea* Jacq., Puerto Colombia, Colombia, Jan. 3,
1933. *J. Dufrenoy*.

This specimen has been supplied by Mr. Cummings from the
Arthur herbarium. It has been reported previously from Ecua-
dor.

PUCCINIA RHAMNI (Pers.) Wettst. Verh. Zool.-Bot. Ges. Wien
35: 545. 1886.

On *Agrostis perennans* (Walt.) Tuckerm., *Chardon* 661, 708.

Avena sativa L., *Toro* 408.

PUCCINIA RIVINAE (Berk. & Curt.) Speg. Anal. Mus. Nac.
Buenos Aires 19: 304. 1909.

On *Rivina humilis* L., Medellin, July 31, 1930, *Archer H-81*.

This is the first report of this species from Colombia.

PUCCINIA ROTUNDATA Diet. Hedwigia 36: 32. 1897.

Puccinia rugosa Speg. Ann. Soc. Ci. Argent. 17: 92. 1884.

Not *P. rugosa* Billings 1871.

On *Vernonia brasiliiana* (L.) Druce, *Chardon & Nolla* 372.

Vernonia patens H.B.K., *Toro* 182; *Mayor* 176c.

Vernonia scabra Pers., *Mayor* 17; *Smith* phan. spec. 613.

Vernonia sp., *Toro* 301, 302; *Chardon & Nolla* 358.

PUCCINIA RUELLIAE (Berk. & Br.) Lagerh. *Tromsö Mus. Aarch.* 17: 71. 1895.

Uredo balaensis Sydow, *Ann. Myc.* 1: 21. 1903.

On *Blechnum Brownei* Juss., *Mayor* 181.

We are following Arthur (N. Am. Flora 7: 415. 1921) in considering the rusts on *Ruellia* and *Blechnum* to be the same. Jackson (Mycologia 24: 95. 1932) prefers to keep the *Blechnum* rust separate under *Puccinia Blechi* Lagerh.

PUCCINIA RUGOSA Speg. See *Puccinia rotundata* Diet.

PUCCINIA RUIZENSIS Mayor, *Mem. Soc. Neuch. Sci. Nat.* 5: 486. 1913.

On *Oreomyrrhris andicola* (H.B.K.) Endlicher, *Mayor* 67.

The teliospore wall is very finely punctate and not smooth as stated in the original description. This fact has been pointed out in a letter received from Dr. Mayor.

PUCCINIA SALVIICOLA Diet. & Holw. See *Puccinia Ballotaeflorae* Long.

PUCCINIA SAMPERI Mayor, *Mem. Soc. Neuch. Sci. Nat.* 5: 537. 1913.

On *Chaenocephalus arboreus* (H.B.K.) O. Hoffm., *Mayor* 12.

A microcyclic rust resembling *Puccinia ferox* on *Verbesina* from which it differs chiefly in the larger size of the teliospores.

PUCCINIA SARACHAE Mayor, *Mem. Soc. Neuch. Sci. Nat.* 5: 499. 1913.

On *Saracha edulis* (Schlecht.) Thellung, *Mayor* 187.

Saracha aff. *edulis* (Schlecht.) Thellung, *Mayor* 188.

Saracha Jaltomata Schlecht., *Toro* (no number).

A microcyclic species.

PUCCINIA SCHISTOCARPHAE Jackson & Holw. *Am. Jour. Bot.* 5: 534. 1918.

On *Schistocarpha* sp., *Toro* 255.

PUCCINIA SCLERIAE (Paz.) Arth. *Mycologia* 9: 75. 1917.

On *Scleria melaleuca* Cham. & Schlecht., *Mayor* 284.

Scleria neogranatensis C. B. Clarke, *C. H. Ballou* H-93.

Scleria sp., *Toro* 233.

It is difficult to determine these specimens which show uredinia only. In our earlier paper (Jour. Dept. Agric. Puerto Rico 14: 335. 1930) we referred the Mayor and Toro specimens to *Puccinia scleriicola*. After studying the Mayor specimen and taking into consideration its host we believe the present disposition is to be preferred. Most certainly these are not *Uromyces Scleriae*. *Puccinia Scleriae* is known from Panama on *Scleria melaleuca*. The Ballou specimen is placed here but not without some doubt.

PUCCINIA SCLERIICOLA Arth. See *Puccinia Scleriae* (Paz.) Arth.

PUCCINIA SIDAERHOMBIFOLIAE Mayor. See *Puccinia Malvacearum* Bertero.

PUCCINIA SMILACIS Schw. Schr. Nat. Ges. Leipzig 1: 72. 1822.
On *Smilax cumanensis* Willd., *Chardon* 568.

PUCCINIA SOLANICOLA Mayor. See *Puccinia claviformis* Lagerh.

PUCCINIA SOLANITA (Schw.) Arth. See *Puccinia claviformis* Lagerh.

PUCCINIA SOLEDADENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 494. 1913.

On *Salvia* ? *pauciserrata* Benth., *Mayor* 79.

PUCCINIA SORGI Schw. Trans. Am. Phil. Soc. II. 4: 295. 1832.
Puccinia Maydis Bereng. Atti Sci. Ital. 6: 475. 1845 (hyponym).

On *Zea Mays* L., *Toro* 202; *Chardon* & *Nolla* 399; *Mayor* 222.

PUCCINIA SPEGAZZINII De-Toni, in Sacc. Syll. Fung. 7: 704. 1888.

Puccinia dubia Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 482. 1913.

Puccinia Convolvulacearum Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 488. 1913.

On *Mikania cordifolia* (L.) Willd., *Chardon* 582, 698; *Chardon* & *Nolla* 277.

Mikania scandens (L.) Willd., *Mayor* 307.

Mikania sp., *Toro* 250, 360; *Mayor* 308b, 309, 315.

Examination of Mayor's specimens 308b and 309, which were said to be on Convolvulaceae indet. and formed the basis of his species *Puccinia Convolvulacearum*, convinces us that they are on *Mikania* and that the rust belongs here. No. 308b may be *M. scandens* and 309 may be *M. cordifolia*. Mayor's specimen no. 315 said to be on Ampelidaceae and used as the type of *Puccinia dubia* appears without doubt to be a *Mikania* and to belong here.

PUCCINIA SPILANTHICOLA Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 531. 1913.

On *Spilanthes americana* (Mutis) Hieron., Mayor 246a, 248.

Spilanthes ciliata H.B.K., Chardon & Nolla 326, 528; Chardon 571, 695.

Except for the mesospores, which are numerous in this species, it is very like *Puccinia Melampodii*.

PUCCINIA STEIRACTINIAE Jackson & Holw. Mycologia 24: 168 1932.

Aecidium Gymnolomiae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 574. 1913. Not *Puccinia Gymnolomiae* Diet. & Holw. 1904.

On *Steiractinia* sp., Mayor 35 (listed by Mayor as *Gymnolomia quitensis* (Benth.) Benth. & Hooker).

Mayor described *Aecidium Gymnolomiae* as a new species with his no. 35 as type specimen. He overlooked some uredinia and telia which occur on the underside of these leaves which bear aecia on the upper surfaces. We have submitted the specimen to Dr. S. F. Blake, U. S. Department of Agriculture, who says the host is *Steiractinia* sp. Jackson has described *Puccinia Steiractiniae* which seems to us to agree perfectly with the Mayor specimen. Jackson's specimen is from Ecuador on *S. Rosei*. Among some undetermined collections kindly sent us by Dr. Mayor we have found one, no. 326, which agrees with no. 35 fairly well as to the rust but Dr. Blake says the host is presumably *Wedelia Jacquinii caracasana* (DC.) O. E. Schultz. The rust, however, does not agree with any rust known to us on *Wedelia*.

PUCCINIA STRIOLATA (Speg.) Arth. Mem. Torrey Club 17: 142. 1918.

- Puccinia macropoda* Speg. Anal. Soc. Ci. Argent. 10: 8. 1880.
On *Iresine* sp., Mayor 52.
- PUCCINIA SUBCORONATA P. Henn. Hedwigia 34: 94. 1895.
Puccinia antioquiensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 473. 1913.
On *Cyperus diffusus* Vahl., Mayor 276.
- PUCCINIA SUBDIGITATA Arth. & Holw.; Arth. Am. Jour. Bot. 5: 468. 1918.
On *Brachypodium mexicanum* Link, Chardon 609, 611.
- PUCCINIA SUBSTRIATA Ellis & Barth. Erythea 5: 47. 1897.
Uredo Henningsii Sacc. Syll. Fung. 17: 456. 1905.
On *Chaetochloa geniculata* (Lam.) Millsp., Chardon & Nolla 324.
Paspalum paniculatum L., Chardon & Nolla 478.
- PUCCINIA SYNEDRELLAE P. Henn. See *Puccinia Melampodii* Diet. & Holw.
- PUCCINIA TAGETICOLA Diet. & Holw.; Holw. Bot. Gaz. 24: 26. 1897.
On *Tagetes microglossa* Benth., Mayor 233.
Tagetes patula L., Toro 244.
- PUCCINIA TOLIMENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 516. 1913.
On *Eupatorium turbacense* Hieron., Toro 343.
Eupatorium turbacense Hieron. var. *ovalifolium* Hieron., Toro 292; Chardon 588.
Eupatorium sp. Mayor 64.
A microcyclic species.
- PUCCINIA TUBULOSA (Pat. & Gaill.) Arth. Am. Jour. Bot. 5: 464. 1918.
Uredo paspalicola P. Henn. Hedwigia 44: 57. 1905.
On *Paspalum conjugatum* Berg., Toro 253; Chardon & Nolla 321; Mayor 165a.
Paspalum Humboldtianum Flügge, Chardon 697.
Paspalum paniculatum L., Chardon & Nolla 271, 434; Chardon 540.
- PUCCINIA VERNONIAE-MOLLIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 510. 1913.

On *Vernonia* cf. *mollis* H.B.K., *Mayor* 172.

Vernonia sp., *Chardon* 591.

The transfer of *Aecidium Vernoniae-mollis* Mayor to this species (Jour. Dept. Agric. Puerto Rico 14: 339. 1930) was an error. See note under *Coleosporium Vernoniae*.

PUCCINIA WEDELIAE Mayor. See *Puccinia Melampodii* Diet. & Holw.

PUCCINIA VON GUNTENI Mayor. See *Prospodium Von Gunteni* (Mayor) Kern & Whetz.

***Puccinia zexmenicola* sp. nov.**

Teleutosoris plerumque hypophyllis, gregariis, quandoque in greges 1-2 mm. dia., plus minusve confluentibus, in maculis flavis insidentibus, minutis, rotundatis, 0.1-0.3 mm. diam., mox nudis, pulvinatis, compactis, primum castaneo-brunneis, dein germinando cinerascens; epidermide rupta inconspicua; teliosporis fusiformibus vel oblongis, 13-19 \times 42-48 μ , apice et basi attenuatis, ad septum leniter constrictis; membrana pallide flavida vel hyalina, 1-1.5 μ cr., apice valde incrassata, 5-10 μ , levi; pedicello hyalina, brevi, sporam dimidiam aequante vel brevior.

On *Zexmenia iners* S. F. Blake, Quebrada de Itagui, Medellin, May 30, 1930 *Archer* H-19.

The only other known micro-*Puccinia* on *Zexmenia*, *P. absicca* Jackson & Holw. from Costa Rica, has teliospores ellipsoid, brown, with hyaline umbos over the pores, and verrucose-rugose walls. This species seems to be quite distinct.

PUCCINIOSIRA Lagerh. Ber. Deuts. Bot. Ges. 9: 344. 1891.

PUCCINIOSIRA PALLIDULA (Speg.) P. Henn. Tromsö Mus. Aarsh. 16: 122. 1894.

On *Malvaceae* sp. (probably *Triumfetta*) *Mayor* 327.

Pavonia paniculata Cav., *Mayor* 192.

Triumfetta semitriloba Jacq., *Toro* 267.

Triumfetta sp., *Chardon & Nolla* 257, 342, 422, 491.

RAVENELIA Berk. Gard. Chron. 10: 132. 1853.

RAVENELIA INDIGOFEAE Tranz. Hedwigia 33: 369. 1894.

On *Indigofera subulata* Vahl., *Toro* 178.

Indigofera suffruticosa Mill., *Chardon & Nolla* 313.

RAVENELIA INGAE (P. Henn.) Arth. N. Am. Fl. 7: 132. 1907.

Uromyces porcensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 459. 1913.

On *Inga adenophylla* Pittier, Toro 190.

Inga edulis Mart., Chardon 110.

Inga cf. *ingoides* (Rich.) Willd., Mayor 311.

Inga spuria H. & B., Archer H-34.

Inga sp., Chardon & Nolla 437, 448, 490; Archer H-155; Chardon 90.

RAVENELIA MAINSIANA Arth. & Holw. Am. Jour. Bot. 5: 426. 1918.

On *Mimosa albida* H.B.K., Chardon 4.

Ravenelia Mimosae-pudicae sp. nov.

Uredosoris hypophyllis, sparsis vel in greges circinatim dispositis, rotundatis, 0.1-0.2 mm. diam., tandem poro centrali apertis, rufo-brunneis; paraphysibus cylindraceis, clavatis, vel spathulatis, $7-12 \times 26-32 \mu$; membrana tenui, 1μ , apice quandoque incrassata ad $2-6 \mu$, hyalina; uredosporis ellipsoideis vel obovoideis, $13-18 \times 18-23 \mu$; membrana hyalina, $1-1.5 \mu$ cr., minute verrucosochinulata; poris obscuris, 6-8, sparsis.

Teleutosporis ignotis.

On *Mimosa pudica* L., Itagui, Aug. 17, 1930, Archer H-108.

It seems odd that a rust has not been described heretofore on *Mimosa pudica* as this plant has been examined frequently by collectors. The combination of characters is such as to make this species distinct from others on closely related species of *Mimosa*.

RAVENELIA MIMOSAE-SENSITIVAE P. Henn. Hedwigia Beibl. 35: 246. 1896.

On *Mimosa sensitiva* L., Mayor 174.

RAVENELIA PITHECOLOBII Arth. Bot. Gaz. 39: 394. 1905.

On *Pithecolobium lanceolatum* Benth. (genus name also written *Pithecellobium*), Chardon & Nolla 374.

SPIRECHINA COLUMBIENSIS Kern & Whetz. See *Mainsia columbiensis* (Kern & Whetz.) Kern, Thurst. & Whetz.

SPIRECHINA CUNDINAMARCENSIS (Mayor) Diet. See *Mainsia cundinamarcensis* (Mayor) Jackson.

SPIRECHINA LAGERHEIMII (P. Magn.) Kern & Whetz. See *Mainsia Lagerheimii* (P. Magn.) Jackson & Holw.

SPIRECHINA LOESENERIANA (P. Henn.) Arth. See *Kuehneola Loeseneriana* (P. Henn.) Jackson & Holw.

SPIRECHINA QUITENSIS (Lagerh.) Kern & Whetz. See *Mainsia Mayorii* Jackson.

SPIRECHINA RUBI-URTICIFOLII (Mayor) Kern & Whetz. See *Mainsia Rubi-urticifolii* (Mayor) Jackson.

SPIRECHINA VARIABILIS (Mayor) Diet. See *Mainsia variabilis* (Mayor) Jackson & Holw.

TRANZSCHELIA Arth. Result. Sci. Congr. Bot. Vienne 340. 1906.

TRANZSCHELIA PUNCTATA (Pers.) Arth. Result. Sci. Congr. Bot. Vienne 340. 1906.

Puccinia Pruni-spinosae Pers. Syn. Fung. 226. 1801.

On *Amygdalus Persica* L., Chardon & Nolla 436; Mayor 5; Chardon 28.

UREDINOPSIS Magn. Atti Congr. Bot. Genova 167. 1893.

UREDINOPSIS MAYORIANA Diet. Mem. Soc. Neuch. Sci. Nat. 5: 556. 1913.

On *Blechnum blechnoides* Lag., Mayor 182b.

No telia are known but the urediniospores and sori indicate the correctness of the reference to the genus *Uredinopsis*.

UREDINOPSIS MACROSPERMA (Cooke) Magn. Hedwigia 43: 122. 1904.

Uredinopsis Pteridis Diet. & Holw. Ber. Deuts. Bot. Ges. 13: 331. 1895.

On *Pteridium aquilinum* (L.) Kuhn., Mayor 183.

UREDIO (Form genus).

UREDIO AESCHYNOMENIS Arth. See *Phakopsora Aeschynomenis* Arth.

UREDIO AGERATI Mayor. See *Puccinia Conoclinii* Seym.

UREDIO AMAGENSIS Mayor. See *Uromyces Hedysari-paniculati* (Schw.) Farl.

UREDIO ANISODERMA Sydow, Monog. Ured. 4: 400. 1924.

Uredo Vernoniae Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 594.

1913. Not *Uredo Vernoniae* P. Henn. 1908.

On *Vernonia* cf. *mollis* H.B.K., Mayor 172g.

This is an unusual form. The sori are small, grouped, long covered by the epidermis. They have somewhat the appearance of large pycnia. The spores are peculiar, being colorless and thicker above. Its identity is doubtful.

UREDIO ANTHURII (Hariot) Sacc. Syll. Fung. 11: 229. 1895.

On *Anthurium* sp., Chardon & Nolla 458.

A rare species but now known also from Puerto Rico and Santo Domingo as well as the type locality in France.

Uredo Archeriana sp. nov.

Uredosoris hypophyllis, plerumque gregatis nervos sequentibus, rotundatis, minutis, 0.2-0.4 mm. diam., mox nudis, pulverulentis, castaneo-brunneis; epidermide rupta inconspicua; uredosporis late ellipsoideis vel obovoideis, 23-26 \times 32-42 μ ; membrana cinnamomeo-brunnea, 1.5-2 μ cr., prominenter spinis hyalinis conicis echinulata; poris 2, subinde 3, subaequatorialibus.

On *Salvia latens* Benth., Sta. Elena, Dec. 28, 1930, Archer H-201.

There are numerous rusts described on the genus *Salvia* but this collection does not agree with any of them. In the described species the urediniospores are comparatively small and globoid or depressed globoid whereas these are large and ellipsoid or obovoid. It seems quite distinct. No teliospores have been found.

UREDIO ARTOCARPI Berk. & Br. Jour. Linn. Soc. 14: 93. 1873.

On *Artocarpus communis* Forst., Chardon & Nolla 282.

UREDIO BACCHARIDIS-ANOMALAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 597. 1913.

On *Baccharis anomala* DC., Mayor 68.

Concerning a closely related species, *Puccinia improcera*, on this host from Brazil see Jackson (Mycologia 24: 145. 1932).

UREDIO BALAENSIS Sydow. See *Puccinia Ruelliae*, (Berk. & Br.) Lagerh.

UREDIO CALEAE Mayor. See *Puccinia Caleae* Arth.

UREDIO CAMELIAE Mayor. See *Puccinia Cameliae* (Mayor) Arth.

UREDIO CAUCENSIS Mayor. See *Crossoporsora caucensis* (Mayor) Kern, Thurst. & Whetz.

UREDIO CHERIMOLIAE Lagerh. Bull. Soc. Myc. Fr. 11: 215. 1895.
On *Annona Cherimolia* Mill., *Chardon & Nolla* 243; *Chardon* 2, 126, 711.

UREDIO CORDIARUM Kern & Whetz. Jour. Dept. Agric. Puerto Rico 14: 344. 1930.

On *Cordia cylindrostachya* (R. & P.) Ros., *Chardon* 646.

UREDIO CUNDINAMARCENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 591. 1913.

On *Apium ternatum* (Willd.) Thellung var. *ranunculifolium* (H.B.K.) Thellung, *Mayor* 30.

UREDIO CUPHEAE P. Henn. Hedwigia 34: 99. 1895.

On *Cuphea serpyllifolia* H.B.K., *Mayor* 198a.

Cuphea strigulosa H.B.K., *Chardon* 702.

Parsonsia pinto (Vand.) Hiller, *Chardon* 31, 69.

Parsonsia racemosa (L. f.) Standley, *Chardon & Nolla* 452.

Parsonsia sp., *Toro* 176, 193.

UREDIO CYATHULAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 584. 1913.

On *Cyathula achyranthoides* (H.B.K.) Moq., *Mayor* 80.

UREDIO DICHROMENAE Arth. See *Puccinia Dichromenae* (Arth.) Jackson.

UREDIO EUPATORIORUM Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 596. 1913.

On *Eupatorium ballotifolium* H.B.K., *Mayor* 219.

Eupatorium densum Benth., *Chardon* 649.

Eupatorium guadalupense Spreng., *Mayor* 227.

Eupatorium iresinoides H.B.K., *Mayor* 191a.

Eupatorium Vargasianum DC., *Mayor* 162.

There are several rusts on the genus *Eupatorium* which are so near identical in the uredinial stage that it is practically impossible to separate them. Among these are *Puccinia Eupatorii* Diet., *Puccinia Conoclinii* Seym., and *Puccinia Eupatorii-Columbiana* Mayor. For this reason it seems wise to retain *Uredo Eupatoriorum* Mayor to which we are referring all of the Colombian specimens on *Eupa-*

torium which have only uredo present. It should be noted that *Uredo Eupatorium* had previously been included as a synonym of *Puccinia Conoclinii* (Jour. Dept. Agric. Puerto Rico 14: 321. 1930).

URED O GOSSYPHII Lagerh. See *Cerotelium desmium* (Berk. & Br.) Arth.

URED O GUACAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 583. 1913.

On *Epidendrum* sp., Mayor 108.

URED O HENNINGSII Sacc.

This name is a synonym of *Puccinia substriata* Ellis & Barth. but the specimen on *Panicum lanatum* Sw. no. 242 referred to this species by Mayor is in this paper included under *Uromyces costaricensis* Sydow.

URED O HYMENAEAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 585. 1913.

On *Hymenaea* sp., Mayor 149.

URED O HYPOXIDIS P. Henn. See *Uromyces affinis* Wint.

URED O HYPTIDIS-ATRO RUBENTIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 593. 1913.

On *Hyptis atropurpurea* Poir., Mayor 238.

URED O JATROPHICOLA Arth. Mycologia 7: 331. 1915.

On *Jatropha gossypifolia* L., Chardon & Nolla 427.

URED O KYLLINGIAE P. Henn. Hedwigia 35: 256. 1896.

On *Kyllingia brevifolia* Rottb., Mayor 279a.

Kyllingia odorata Vahl., Mayor 280.

Kyllingia sp., Chardon 677.

URED O MANDEVILLAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 591. 1913.

On *Mandevilla* cf. *mollissima* (H.B.K.) K. Schum., Mayor 226.

Reported also from Trinidad (Sydow, Monog. Ured. 4: 432. 1924).

URED O MYRCIAE Mayor. See *Puccinia Psidii* Wint.

UREDOPHORELEPIDIS Diet.; Mayor, Mem. Soc. Neuch. Sci. Nat.
5: 576. 1913.

On *Nephrolepis pendula* Raddi., Mayor 151a.

UREDOPHORELEPIDIS Jackson & Holw. Mycologia 18: 144. 1926.

On *Cyperus ferax* L. C. Rich., Chardon & Nolla 212.

Through the kindness of Dr. Jackson we have had opportunity to examine the type of *U. nociviola* and find that our specimen agrees as to size, color, markings, and pores of the spores.

UREDOPHORELEPIDIS P. Henn. See *Puccinia tubulosa* (Pat. & Gaill.) Arth.

? UREDOPHORELEPIDIS P. Henn. Hedwigia 38: 69. 1899.

On *Piper antioquiense* C. DC., Chardon & Nolla 461.

UREDOPHORELEPIDIS P. Henn. Hedwigia Biebl. 38: 70. 1899.

On *Piper Hartwegianum* C. DC., Chardon & Nolla 462.

UREDOPHORELEPIDIS Mayor. See *Puccinia Ballotaeflorae* Long.

UREDOPHORELEPIDIS Cooke, Grevillea 15: 18. 1886.

On *Vanilla planifolia* Griseb., reported from Colombia by G. Lindau (Orchis 9: 177. 1915).

UREDOPHORELEPIDIS Mayor. See *Phakopsora Vignae* (Bres.) Arth.

UREDOPHORELEPIDIS Neger, Beih. Bot. Centralb. B. 13: 8. 1903.

On *Crotalaria anagyroides* H.B.K., Therese, Prinzessin von Bayern.

UREDOPHORELEPIDIS Kern & Whetz. Jour. Dept. Agric. Puerto Rico
14: 347. 1930.

On *Solanum* sp., Chardon 569.

UREDOPHORELEPIDIS P. Henn. Hedwigia 44: 57. 1905.

On *Torulinum ferax* (L. C. Rich.) Urban, Mayor 133.

Through the kindness of Dr. W. H. Weston, of the Farlow Herbarium, we have had the opportunity to examine Mayor's specimen. We find that Mayor was right in saying that his specimen agreed well with the description of Hennings. Nothing was said in the original description about pores. They are apparently 2, equatorial. The markings are perhaps better described as verrucose-echinulate than as verrucose.

UREDIO UNILATERALIS Arth. Bull. Torrey Club 45: 155. 1918.

On *Geranium hirtum* Willd., Chardon 596.

Geranium mexicanum H.B.K., Mayor 33.

Mayor called his collection no. 33, *Uromyces Geranii* but there is no question that it belongs here as the uredospores have the typical reniform shape with one pore on the concave side. The specimen on *Geranium hirtum* has on it an aecial form in addition to the uredo (See Kern & Whetzel, 1930, p. 347). These aecia differ from *Aecidium bogotense* Mayor in the smaller spores and lack of peridium. No telial stage is known. Jackson reports this species from Ecuador.

UREDIO VERNONIAE Mayor. See *Uredo anisoderma* Sydow.

UREDIO ZEUGITIS Arth. & Holw.; Arth. Am. Jour. Bot. 5: 538. 1918.

On *Zeugites mexicana* (Kunth.) Trin., Chardon 52.

UROMYCES Unger, Exanth. Pfl. 277. 1833.

UROMYCES AFFINIS Wint. Hedwigia 24: 259. 1885.

Uredo Hypoxidis P. Henn. Hedwigia 40: 173. 1901.

On *Hypoxis decumbens* L., Mayor 230a.

UROMYCES ANTIOQUIENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 445. 1913.

On *Rhyncospora polyphylla* Vahl., Mayor 261.

This species differs from *U. Rhyncosporae* Ellis and *U. oblectaneus* Jackson & Holw. in the uredinial characters. Both the sori and spores are lighter colored in the Mayor species and there are also differences in the thickness and wall markings.

UROMYCES APPENDICULATUS (Pers.) Fries, Summa. Veg. Scand. 514. 1849.

On *Phaseolus lunatus* L., Chardon 81, 648; Chardon & Nolla 280a.

Phaseolus vestitus Hooker, Archer H-101.

Phaseolus vulgaris L., Toro 203; Chardon 298; Chardon & Nolla 530; Archer H-6.

For rust on *Vigna* see *Uromyces Vignae*.

UROMYCES ASCLEPIADIS (Schw.) Cooke, Grevillea 5: 152. 1879.

On *Asclepias curassavica* L., Chardon & Nolla 328.

UROMYCES BIDENTICOLA (P. Henn.) Arth. Mycologia 9: 71. 1917.

On *Bidens cynapiifolia* H.B.K., Mayor 100.

Bidens pilosa L., Chardon 61, 104, 586; Mayor 211e.

Bidens squarrosa H.B.K., Chardon 645; Mayor 42.

This is a macrocyclic species of which uredinia and telia are known. It is not to be confused with *U. Bidentis* Lagerh., a microcyclic species which is known on *Bidens pilosa*. Mayor (p. 470) reported this species from Colombia on *B. pilosa* and *B. squarrosa* but called it *U. Bidentis* in error. Reference to the host *B. bipinnata* (Mycologia 19: 271. 1927) as from Colombia is also an error as that specimen was from Jamaica and not Colombia. The microcyclic species *U. Bidentis* is also reported from Colombia in this paper.

UROMYCES BIDENTIS Lagerh. Bull. Soc. Myc. Fr. 11: 213. 1895.

On *Bidens pilosa* L., Chardon & Nolla 450.

See note under *Uromyces bidenticola*.

UROMYCES CESTRI (Mont.) Lév. Ann. Sci. Nat. III. 8: 371. 1847.

On *Cestrum parviflorum* Dun., Toro 406.

Cestrum sp., Toro 366.

UROMYCES CISSAMPELIDIS Diet.; Earle, Bull. Torrey Club 26: 632. 1899.

On *Cissampelos* sp., Baker 83.

UROMYCES COLUMBIANUS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 467. 1913.

On *Melanthera aspera* (Jacq.) Steudel, Chardon 120; Mayor 293.

Melanthera aspera (Jacq.) Steudel var. *canescens* (O. Kuntz) Thellung, Mayor 148.

UROMYCES COMMELINAE (Speg.) Cooke, Trans. Roy. Soc. Edinb. 31: 342. 1888.

Uromyces Spegazzinii Arth., Bull. Torrey Club 37: 573. 1910.

On *Tradescantia cumanensis* Kunth, Toro 207.

Tradescantia multiflora L., Mayor 178; Archer H-49.

UROMYCES COSTARICENSIS Sydow, Ann. Myc. 23: 312. 1925.

On *Lasiacis ruscifolia* (H.B.K.) Hitchc., Toro 179.

Lasiacis sorghoidea (Desv.) Hitchc. & Chase (*Panicum lanatum* Sw.), Chardon & Nolla 439, 514; Mayor 242.

Mayor originally referred his collection, no. 242, to *Uredo Henningsii*. In studying his specimen we have found teliospores as well as urediniospores. In our previous paper (Jour. Dept. Agric. Puerto Rico 14: 315) we referred all the specimens listed here to *Uromyces leptodermus*. Since that time we have had for examination the type specimens of *U. leptodermus* and *U. costaricensis* and have reached the conclusion that all of these collections are properly referred to the latter. For further discussion see paper by Thurston entitled The Standing of Two Species of *Uromyces* on *Panicum* (Mycologia 25: 442-445. 1933).

UROMYCES CRUCHETI Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 464. 1913.

On *Borreria tenella* (H.B.K.) Cham. & Schlecht., Mayor 264.

Rubiaceae undet., Toro 265.

Sydow (Ann. Myc. 28: 37. 1930) says the Mayor specimen may belong to the genus *Borreria* but that it is not the species *B. tenella*.

UROMYCES CUNDINAMARCENSIS Mayor. See *Mainsia cundinamaricensis* (Mayor) Jackson.

UROMYCES DOLICHOLI Arth. Bull. Torrey Club 33: 27. 1906.

On *Rhynchosia* cf. *longeracemosa* Mart. & Gall., Mayor 273.

UROMYCES ERAGROSTIDIS Tracy, Jour. Myc. 7: 281. 1893.

On *Eragrostis pilosa* (L.) Link, Escuela de Agricultura, Medellin, July 2, 1930, Archer H-68; Medellin, June 11, 1930, Archer H-44.

The collection no. H-68 has an abundance of teliospores. This species has been reported from Brazil, Bolivia, and Ecuador by Arthur (Proc. Amer. Phil. Soc. 64: 210. 1925) but this is the first report from Colombia.

UROMYCES EUPHORBIICOLA (Berk. & Curt.) Tranz. See *Uromyces proeminens* (DC.) Pass.

UROMYCES FABAE (Pers.) deBary, Ann. Sci. Nat. IV. 20: 80. 1863.

On *Vicia Faba* L., Toro 263; Archer H-189.

UROMYCES GERANII (DC.) Ott. & Wartm. as used by Mayor, p. 462.

Error for *Uredo unilateralis* Arth.

UROMYCES GURANIAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 466. 1913.

On *Gurania* sp., Mayor 324.

On Mayor's specimen no. 324 we have found urediniospores inter-mixed in sori with the teliospores. A few sori look as if they were uredinia with teliospores developing in them. The urediniospores are broadly ellipsoid or globoid, $15-19 \times 19-26 \mu$, the wall is yellowish or pale cinnamon-brown, $1-1.5 \mu$ thick, moderately echinulate, the pores 2, equatorial. We do not think the species is a *lepto-Uromyces*.

UROMYCES HEDYSARI-PANICULATI (Schw.) Farl.; Ellis, N. Am. Fungi 246. 1879.

Uredo amagensis Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 584. 1913.

On *Desmodium mexicanum* Sweet, Therese, Prinzessin von Bayern.

Desmodium tortuosum (Sw.) DC., Mayor 266.

Desmodium sp., Mayor 270.

UROMYCES HYPERICI-FRONDOSI (Schw.) Arth. Bull. Minn. Acad. Sci. 2^d: 15. 1883.

On *Hypericum* aff. *uliginosum* H.B.K., Mayor 75 (not seen).

Hypericum thesiifolium H.B.K., Archer H-129.

UROMYCES IRESINES Lagerh.; Sydow, Monog. Ured. 2: 227. 1910.

On *Iresine paniculata* (L.) Kuntze, Mayor 180b.

UROMYCES JANIPHAЕ (Wint.) Arth. Mycologia 7: 190. 1915.

On *Manihot utilissima* Pohl (*M. Manihot* Cockerell), Baker 84; Archer H-56.

In our previous paper (Jour. Agric. Puerto Rico 14: 315. 1930) we listed the Baker specimen as *Uromyces Manihotis* P. Henn. as that was the name given it by Dietel (Bull. Torrey Club 26: 632. 1899). Since that time we have had for study a part of the Baker collection made available through the kindness of Dr.

G. Samuelsson, of Stockholm. He has also furnished us a part of the type of *U. Manihotis* P. Henn. collected by E. Ule in Brazil. Dietel commented that Hennings described only teliospores in *U. Manihotis* but that on specimens received from Hennings he found also uredospores which corresponded exactly with Baker's no. 84. Our portion of *U. Manihotis* does not have on it any urediniospores and we are still in doubt about the life-history and standing of that species. Our studies of Baker's no. 84 shows the urediniospores to be identical with what we call *Uromyces Janiphae* in North America. In addition we now have the Archer no. H-56 from Medellin which is also identical. There seems to be no doubt that both these Colombian collections are the same as the rust which is more or less common on cultivated cassava in central Mexico and the West Indies.

UROMYCES LAGERHEIMII P. Magn. See *Mainsia Lagerheimii* (P. Magn.) Jackson & Holw.

UROMYCES LEPTODERMUS Sydow; Sydow & Butler, Ann. Myc. 4: 430. 1906.

On *Panicum barbinode* Trin., Chardon 5.

On this specimen we find only urediniospores which makes the determination less certain than if teliospores were present. Since we have two specimens, one from St. Croix and one from Santo Domingo, on this same host with both uredinia and telia agreeing with *U. leptodermus* we are inclined to believe this reference is correct. See also note under *Uromyces costaricensis*.

UROMYCES LOESENERIANUS (P. Henn.) Sydow. See *Kuehneola Loeseneriana* (P. Henn.) Jackson & Holw.

UROMYCES MANIHOTIS P. Henn. See *Uromyces Janiphae* (Wint.) Arth.

UROMYCES MAYORII Tranz.; Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 463. 1913.

On *Euphorbia orbiculata* H.B.K., Mayor 50.

According to the original description this is a microcyclic species with an unlimited mycelium. The teliospores themselves are very like the teliospores of *U. proëminens*. Arthur & Cummins have described (Ann. Myc. 31: 44. 1933) a microcyclic species with

systemic mycelium and similar spores on *Euphorbia lata* from Colorado, Kansas, and Texas. They have named the species *U. largus*. Through the kindness of Dr. Arthur we have had the type for examination and have failed to find any reason to keep it separate from *U. Mayorii*. There is also a Stevens specimen from Peru on *E. orbiculata* that has been called *U. proëminens* which undoubtedly belongs here.

UROMYCES MEGALOSPERMUS Speg. Anal. Mus. Nac. Buenos Aires 218. 1899.

On *Tessaria integrifolia* Ruiz. & Pav., *Toro* 242; *Chardon* 3; *Mayor* 254.

UROMYCES NERVIPHILUS (Grognot) Barth. Handb. N. Am. Ured. 69. 1928.

On *Trifolium repens* L., *Toro* 407, 411.

UROMYCES NEUROCARPI Diet. Hedwigia 34: 292. 1895.

On *Martiusia rubiginosa* (Juss.) Britton, *Toro* 368.

UROMYCES PHTIRUSAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 448. 1913.

On *Phtirusa pyrifolia* (H.B.K.) Eichler, *Mayor* 169.

The strongly striate spores described by Mayor as teliospores are in reality urediniospores. Genuine 1-celled teliospores are present which go to show that this is a *Uromyces*. For discussion see Jackson, *Mycologia* 19: 54. 1927.

UROMYCES POLYMNIAE (P. Henn.) Diet. & Holw. Bot. Gaz. 31: 327. 1901.

On *Polymnia glabrata* DC., *Mayor* 11.

We have compared the Mayor collection with the type specimen of *Uromyces Polymniae* and find that it agrees very well. We do not think that the pores are either two equatorial or subequatorial as they have been reported. We find three or four pores and cannot make out any definite arrangement.

UROMYCES PORCENSIS Mayor. See *Ravenelia Ingae* (P. Henn.) Arth.

UROMYCES PROËMINENS (DC.) Pass. Rab. Fungi Eur. 1795. 1873.

Uromyces euphorbiicola Tranz. Ann. Myc. 8: 8. 1910.

On *Chamaesyce brasiliensis* (Lam.) Small (*Euphorbia brasiliensis* Lam.), Toro 240.

Chamaesyce hirta (L.) Millsp. (*Euphorbia pilulifera* L.), Chardon & Nolla 254, 360, 397; Chardon 22, 116; Mayor 201b; Archer H-209.

UROMYCES QUITENSIS Lagerh. See *Mainsia Mayorii* Jackson.

UROMYCES RUBI-URTICIFOLII Mayor. See *Mainsia Rubi-urticifolii* (Mayor) Jackson.

UROMYCES SCLERIAE P. Henn. See *Puccinia Scleriae* (Paz.) Arth.

UROMYCES SMILACIS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 448. 1913.

On *Smilax* sp., Mayor 323.

UROMYCES SOLANI Diet. & Holw. Bot. Gaz. 24: 24. 1897.

On *Solanum* sp., Chardon 675.

UROMYCES SPEGAZZINII (De-Toni) Arth. See *Uromyces Commelinae* (Speg.) Cooke.

UROMYCES URBANIANUS P. Henn. Hedwigia 36: 213. 1897.

On *Antidaphne Fendleri* Engler, Archer H-94.

Oryctanthus botryostachys Eichl., Chardon & Nolla 435; Archer H-98.

This is an opsis-form and both collections on *Oryctanthus* have aecia and telia present. The *Antidaphne* specimen has only aecia. *Aecidium Loranthe* Thuem. on *Loranthus* is very similar.

UROMYCES VARIABILIS Mayor. See *Mainsia variabilis* (Mayor) Jackson & Holw.

UROMYCES VIGNAE Barclay, Jour. Asiat. Soc. Bengal 60: 211. 1891.

On *Vigna luteola* (Jacq.) Benth. Mayor 272; Archer H-38.

We are following Fromme (Phytopath. 14: 67-79. 1924) in separating the rust on *Vigna* from *Uromyces appendiculatus*. The chief distinction is in the pore characters. Both have two pores but on *Vigna* they are more evident and superequatorial whereas in *U. appendiculatus* they are equatorial.

HOST INDEX

- Adenaria floribunda**
Adenaria floribunda purpurata
Aecidium Adenariae
Aeschynomene americana
Aeschynomene sensitiva
Phakopsora (?) *Aeschynomenis*
Ageratum conyzoides
Ageratum conyzoides var. inaequi-
paleaceum
Puccinia Conoclinii
Agrostis perennans
Puccinia poculiformis
Puccinia Rhamni
Amygdalus Persica
Tranzschelia punctata
Annona Cherimolia
Uredo Cherimoliae
Anoda cristata
Puccinia Anodae
Anoda hastata
Puccinia Anodae
Puccinia heterospora
Antheophora hermaphrodita
Puccinia Chaseanum
Anthoxanthum odoratum
Puccinia poculiformis
Anthurium sp.
Uredo Anthurii
Antidaphne Fendleri
Uromyces Urbanianus
Apium ternatum ranunculifolium
Uredo cundinamarcensis
Artocarpus communis
Uredo Artocarp
Asclepias curassavica
Uromyces Asclepiadis
Avena sativa
Puccinia poculiformis
Puccinia Rhamni
Axonopus scoparius
Puccinia levis
Baccharis anomala
Uredo Baccharidis-anomala
Baccharis bogotensis
Puccinia Montserrates
Baccharis cassinaefolia
Puccinia evadens
Baccharis floribunda
Puccinia caeomatiformis
Puccinia Montoyae
Baccharis nitida
Puccinia Ancizari
Baccharis oronocensis
Puccinia Mayerhansi
Baccharis polyantha
Puccinia caeomatiformis
Baccharis rhexioides
Puccinia Baccharidis-rhexioides
Bastardia viscosa
Puccinia heterospora
Berberis rigidifolia
Aecidium (?) *aridum*
Bidens cynapifolia
Uromyces bidenticola
Bidens pilosa
Uromyces bidenticola
Uromyces Bidentis
Bidens squarrosa
Uromyces bidenticola
Blechnum blechnoides
Uredinopsis Mayorianae
Blechnum occidentale
Milesia australis
Blechnum Brownei
Puccinia Ruelliae
Bocconia frutescens
Coleosporium Bocconiae
Puccinia Bocconiae
Bomarea cf. Caldasii
Bomarea potacocensis
Puccinia Bomareae
Bombax sp.
Puccinia Bombacis
Borreria laevis
Borreria latifolia
Puccinia lateritia
Borreria tenella
Uromyces Crucheti
Brachistus cf. hebeophyllus
Puccinia Ortizi
Brachypodium mexicanum
Puccinia subdigitata
Bromus unioloides
Puccinia Clematidis

- Buettneria carthaginensis**
Puccinia filopes
Calea glomerata
Puccinia Caleae
Canna coccinea
Canna sp.
Puccinia Cannae
Capriola Dactylon
Puccinia Cynodontis
Capsicum baccatum
Aecidium Capsici
Capsicum cf. **baccatum**
Puccinia Capsici
Capsicum sp.
Puccinia Gonzalezi
Cardiospermum sp.
Puccinia Arechavelatae
Cenchrus echinatus
Puccinia Cenchrus
Cestrum parviflorum
Cestrum sp.
Uromyces Cestri
Chaenocephalus arboreus
Puccinia Samperi
Chaetochloa geniculata
Puccinia substriata
Chaetochloa scandens
Puccinia Camelliae
Chamaesyce brasiliensis
Chamaesyce hirta
Uromyces proeminens
Cissampelos sp.
Uromyces Cissampelidis
Cissus rhombifolia
Crossospora caucensis
Cissus sicyoides
Cissus sp.
Endophyllum circumscriptum
Clibadium surinamense
Clibadium surinamense asperum
Endophyllum decoloratum
Cordia cylindrostachya
Uredo Cordiarum
Cordia ferruginea
Cordia laxiflora
Alveolaria Cordiae
Crotalaria anagyroides
Uredo Theresiae
Croton gossypifolius
Phakopsora columbiana
Cuphea serpyllifolia
Cuphea strigulosa
Uredo Cupheae
Cyathula achyranthoides
Uredo Cyathulae
Cyperus caracasanus
Puccinia Cyperi
Cyperus diffusus
Puccinia subcoronata
Cyperus ferax
Puccinia canaliculata
Uredo nociviola
Cyperus globulosus
Puccinia Cyperi
Cyperus sp.
Puccinia abrepta
Dennstaedtia rubiginosa
Milesia Dennstaedtia
Desmodium mexicanum
Desmodium tortuosum
Desmodium sp.
Uromyces Hedysari-paniculati
Dichromena ciliata
Dichromena polystachys
Dichromena radicans
Dichromena sp.
Puccinia Dichromenae
Diodia cymosa
Puccinia lateritia
Elephantopus mollis
Elephantopus scaber
Elephantopus spicatus
Elephantopus sp.
Coleosporium Elephantopodis
Eleutheranthera ruderalis
Puccinia Melampodii
Epidendrum sp.
Uredo Guacae
Eragrostis inconstans
Puccinia eragrostidicola
Eragrostis pilosa
Uromyces Eragrostidis
Erigeron bonariensis
Aecidium Spegazzinii
Puccinia Cyperi
Erigeron cf. **uliginosus**
Puccinia Asteris

- Erythrina glauca**
Dicheirinia binata
Eupatorium ballotifolium
Uredo Eupatorium
Eupatorium columbianum
Puccinia Eupatorii-columbiani
Eupatorium conyzoides
Cronartium praelongum
Eupatorium densum
Eupatorium guadalupense
Uredo Eupatorium
Eupatorium inulifolium
Cronartium praelongum
Eupatorium iresinoides
Uredo Eupatorium
Eupatorium macrophyllum
 See *Hebeclinium macrophyllum*
Eupatorium morifolium
Cronartium praelongum
Eupatorium obscurifolium
Aecidium paramense
Eupatorium odoratum
Eupatorium popayanense
Eupatorium pomaderrifolium
Cronartium praelongum
Eupatorium pycnocephalum
Eupatorium Schiedeanum
Puccinia eupatoriicola
Eupatorium tacotanum
Eupatorium tequendamense
Eupatorium thyrigerum
Cronartium praelongum
Eupatorium turbacense
Eupatorium turbacense ovalifolium
Puccinia tolimensis
Eupatorium Vargasianum
Uredo Eupatorium
Eupatorium sp.
Cronartium praelongum
Puccinia nariñensis
Puccinia tolimensis
Euphorbia brasiliensis
 See *Chamaesyce brasiliensis*
Euphorbia orbiculata
Uromyces Mayorii
Euphorbia pilulifera
 See *Chamaesyce hirta*
Evolvulus villosus
Puccinia Lithospermi
- Exolobus** sp.
Puccinia obliqua
Ficus Carica
Cerotelium Fici
Fimbristylis annua
Puccinia Fimbristylidis
Geranium hirtum
Geranium mexicanum
Uredo unilateralis
Geranium multiceps
Aecidium bogotense
Puccinia bogotensis
Gossypium barbadense
Gossypium hirsutum
Gossypium peruvianum
Gossypium cf. *religiosum*
Gossypium sp.
Cerotelium desmum
Gouania sp.
Puccinia Gouaniae
Gurania sp.
Uromyces Guraniae
Hebeclinium macrophyllum
Coleosporium Eupatorii
Heliopsis buphthalmoides
Puccinia Bimbergi
Hemidiodia ocimifolia
Aecidium Borreriae
Holcus Sorghum
Puccinia purpurea
Hydrocotyle leucocephala
Hydrocotyle quinqueloba var. *stella*
Hydrocotyle umbellata
Puccinia Hydrocotyles
Hymenaea sp.
Uredo Hymenaeae
Hypericum thesiifolium
Hypericum cf. *uliginosum*
Uromyces Hyperici-frondosi
Hypoxis decumbens
Uromyces affinis
Hyptis atrorubens
Uredo Hyptidis-atrorubentis
Hyptis capitata vulgaris
Puccinia Hyptidis
Hyptis mutabilis polystachya
Puccinia Hyptidis-mutabilis

- Hyptis mutabilis spicata**
Puccinia Hyptidis-mutabilis
Puccinia Menthae
Hyptis pectinata
Puccinia medellinensis
Indigofera subulata
Indigofera suffruticosa
Ravenelia Indigoferae
Inga adenophylla
Inga edulis
Inga cf. ingoides
Inga spuria
Inga sp.
Ravenelia Ingae
Ipomoea cf. caloneura
Coleosporium Ipomoeae
Puccinia crassipes
Ipomoea carnea
Puccinia puta
Ipomoea sp.
Coleosporium Ipomoeae
Puccinia crassipes
Iresine paniculata
Uromyces Iresines
Iresine sp.
Puccinia striolata
Jacquemontia sp.
Coleosporium Ipomoeae
Jambos Jambos
Puccinia Psidii
Jatropha gossypifolia
Uredo jatrophiicola
Justicia cf. secunda intermedia
Puccinia Fuhrmanni
Kyllingia brevifolia
Kyllingia odorata
Kyllingia sp.
Uredo Kyllingiae
Lantana camara
Puccinia Lantanae
Lantana hispida
Aecidium Lantanae
Puccinia Lantanae
Lantana tiliifolia
Lantana trifolia
Puccinia Lantanae
Lasiacis ruscifolia
Lasiacis sorghoidea
Uromyces costaricensis
- Leonotis nepetaefolia**
Puccinia Leonotidis
Liabum hastatum
Puccinia Liabi
Liabum igniarum
Aecidium Liabi
Lippia americana
Lippia sp.
Prospodium Von Gunten
Lucuma sp.
Puccinia Lucumae
Lupinus sp.
Chrysocelis Lupini
Malvaceae sp.
Puccinia heterospora
Pucciniosira pallidula
Malvastrum americanum
 See *Malvastrum tricuspidatum*
Malvastrum corchorifolium
Malvastrum coromandelianum
Puccinia Malvacearum
Malvastrum peruvianum
Puccinia heterospora
Malvastrum tricuspidatum
Malvastrum sp.
Puccinia Malvacearum
Mandevilla cf. mollissima
Uredo Mandevillae
Manettia Toroi
Aecidium Manettiae
Manihot Manihot
 See *Manihot utilissima*
Manihot utilissima
Uromyces Janiphae
Manisuris granularis
 See *Rytillix granularis*
Mariscus flavus
Mariscus hermaphroditus
Puccinia Marisci
Martusia rubiginosa
Uromyces Neurocarpi
Melanthera aspera
Melanthera aspera canescens
Uromyces columbianus
Mikania cordifolia
Puccinia Spegazzinii
Mikania Guaco
Endophylloides portoricensis
Mikania scandens

- Mikania** sp.
Puccinia Spegazzinii
Mimosa albida
Ravenelia Mainsiana
Mimosa pudica
Ravenelia Mimosae-pudicae
Mimosa sensitiva
Ravenelia Mimosae-sensitivae
Myrcia cf. *acuminata*
Myrcia sp.
Myrtaceae sp.
Puccinia Psidii
Nephrolepis pendula
Milesia columbiensis
Uredo Nephrolepidis
Oreomyrrhis andicola
Puccinia ruizensis
Oryctanthus botryostachys
Uromyces Urbanianus
Oxalis pubescens
Oxalis sp.
Puccinia Oxalidis
Oyedaea cf. *bupthalmoides*
Puccinia Oyedaeae
Panicum barbinode
Uromyces leptodermis
Panicum lanatum
 See *Lasiacis sorghoidea*
Parsonsia pinto
Parsonsia racemosa
Parsonsia sp.
Uredo Cupheae
Paspalum conjugatum
Paspalum Fournierianum maximum
Puccinia levis
Paspalum Humboldtianum
Puccinia tubulosa
Paspalum macrophyllum
Puccinia Chaetochloae
Paspalum paniculatum
Puccinia substriata
Puccinia tubulosa
Paspalum pilosum
Puccinia levis
Paspalum prostratum
Puccinia atra
Pavonia paniculata
Pucciniosira pallidula
Pennisetum bambusiforme
Puccinia Cenchrī
Persicaria hydropiperoides
Persicaria persicarioides
Persicaria punctata
Puccinia Polygoni-amphibii
Phaseolus lunatus
Phaseolus vestitus
Phaseolus vulgaris
Uromyces appendiculatus
Phleum pratense
Puccinia poculiformis
Phthirusa pyrifolia
Uromyces Phthirusae
Piper antioquiense
Uredo Peperomiae
Piper Hartwegianum
Uredo Piperis
Pithecolobium lanceolatum
Ravenelia Pithecolobii
Plumiera alba
Plumiera rubra
Plumiera sp.
Coleosporium domingense
Poa annua
Poa pratensis
Puccinia epiphylla
Polygonum acre
 See *Persicaria punctata*
Polymnia glabrata
Uromyces Polymniae
Psidium sp.
Puccinia Psidii
Pteridium aquilinum
Uredinopsis macrosperma
Quamoclit angulata
Quamoclit coccinea
Coleosporium Ipomoeae
Relbunium hypocarpium
Puccinia punctata
Rhynchosia cf. *longeracemosa*
Uromyces Dolicholi
Rivina humilis
Puccinia Rivinae
Rosa sp.
Phragmidium disciflorum
Rubiaceae
Uromyces Crucheti

- Rubus adenotrichos**
Mainsia Rubi-urticifolii
Rubus glaucus
Mainsia Lagerheimii
Rubus peruvianus
Mainsia cundinamarcensis
Rubus urticifolius
Kuchneola Loesneriana
Mainsia Rubi-urticifolii
Rubus sp.
Mainsia columbiensis
Mainsia Lagerheimii
Mainsia Mayorii
Mainsia Rubi-urticifolii
Mainsia variabilis
Rynchospora polyphylla
Uromyces antioquiensis
Rytillix granularis
Puccinia levis
Salvia cataractarum
Puccinia Ballotaeflorae
Salvia cernua
Puccinia paramensis
Salvia latens
Uredo Archeriana
Salvia Mayorii
Puccinia Ballotaeflorae
Salvia palaefolia
 (?) *Puccinia conturbata*
Salvia (?) pauciserrata
Puccinia soledadensis
Salvia petiolaris
Puccinia Ballotaeflorae
Puccinia impedita
Sapindaceae sp.
Puccinia Arechavelatae
Saracha edulis
Saracha cf. edulis
Saracha Jaltomata
Puccinia Sarachae
Schistocarpa sp.
Puccinia Schistocarphae
Scleria melaleuca
Scleria neogranatensis
Scleria sp.
Puccinia Scleriae
Serjania cf. brevipes
Serjania membranacea
- Serjania sp.**
Puccinia Arechavelatae
Setaria scandens
 See *Chaetochloa scandens*
Sida rhombifolia
Puccinia heterospora
Puccinia Malvacearum
Sida spinosa
Puccinia heterospora
Smilax cumanensis
Puccinia Smilacis
Smilax sp.
Uromyces Smilacis
Solanum hirtum
Solanum cf. myrianthum
Solanum cf. ovalifolium
Solanum stramonifolium
Solanum torvum
Solanum cf. torvum
Puccinia claviformis
Solanum tuberosum
Puccinia Pittieriana
Solanum sp.
Puccinia claviformis
Uredo tolimensis
Uromyces Solani
Spilanthes americana
Spilanthes ciliata
Puccinia spilantheticola
Spilanthes urens
Puccinia Barranquillae
Stachys Mayorii
Puccinia pallidissima
Stachytarpheta cayennensis
 See *Valerianodes cayennense*
Steiractinia sp.
Puccinia Steiractiniaae
Stipa neesiana
Puccinia poculiformis
Synedrella nodiflora
Puccinia Melampodii
Tagetes microglossa
Tagetes patula
Puccinia tageticola
Teramnus uncinatus
Phakopsora Vignae
Tessaria integrifolia
Uromyces megalospermus

- Torulinum ferax**
Uredo Torulini
Tradescantia cumanaensis
Tradescantia multiflora
Uromyces Commelinae
Trifolium repens
Uromyces nervophilus
Triticum aestivum
Puccinia Clematidis
Puccinia glumarum
Puccinia poculiformis
Triumfetta semitriloba
Triumfetta sp.
Pucciniosira pallidula
Valerianodes cayennense
Endophyllum Stachytarphetae
Vanilla planifolia
Uredo Scabies
Verbesina (?) **nudipes**
Verbesina **verbasifolia**
Verbesina sp.
Puccinia ferox
Vernonia brasiliiana
Puccinia rotundata
Vernonia **Cotoneaster**
Puccinia Becki
Vernonia cf. **mollis**
Coleosporium Vernoniae
Puccinia Vernoniae-mollis
Uredo anisoderma
Vernonia patens
Vernonia scabra
Puccinia rotundata
Vernonia sp.
Puccinia rotundata
Puccinia Vernoniae-mollis
Vicia Faba
Uromyces Fabae
Vigna luteola
Uromyces Vignae
Vitis sicyoides
 See **Cissus sicyoides**
Vitis sp.
Phakopsora Vitis
 See also **Cissus** sp.
Wedelia caracasana
Puccinia Melampodii
Wedelia carnosa
Endophyllum decoloratum
Wedelia Trichostephia
Puccinia Melampodii
Wissadula periplocifolia
Puccinia heterospora
Zea Mays
Puccinia pallescens
Puccinia Sorghi
Zeugites mexicana
Uredo Zeugitis
Zexmenia iners
Puccinia zexmenicola

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LIFE HISTORY AND SYNONYMY OF *PHYSALOSPORA GLANDICOLA*

NEIL E. STEVENS

The recent report by O. C. Boyd¹ of a twig blight of several species of oak in Massachusetts, caused by a pyrenomycete makes desirable the prompt publication of information regarding the life history and synonymy of this fungus which otherwise might well have been delayed and included with a more general study of species of this group.

By coincidence the fungus in question had at the time Boyd made his observations been a subject of study for several months on the basis of material from Toronto, Canada. In March, 1932, H. S. Jackson sent to us for identification excellent material of a pyrenomycete on oak collected by him near Toronto, Canada. The ascospores proved to be readily viable and single ascospore cultures grown on cornmeal in flasks under conditions described in earlier articles produced abundant pycnospores. The description here given is based on the Toronto material, though specimens of the Massachusetts material have also been deposited in the mycological collections of the Bureau of Plant Industry.

The fungus which for reasons given below has been designated as *Physalospora glandicola* (Schw.) comb. nov. has black erumpent stromata mostly 1 to 2 mm. in diameter scattered irregularly over the bark of the host. When cut across, pycnidia and perithecia, except when too old, show the snowy white contents characteristic of the genus *Physalospora*.

Perithecia as well as pycnidia being crowded together in the stromata are somewhat irregular in shape and size but rarely exceed 200 to 225 μ in diameter. The asci are regularly eight-spored and the ascospores while hyaline and non-septate up to the time they attain full size become light brown and usually two-septate before being discharged from the asci. The ascospores in this specimen are rather uniform in size being 14-16 \times 30-35 μ .

¹ Pl. Dis. Repr. Sup. 85: 67. 1933.

Hyaline paraphyses or pseudoparaphyses of the irregular semi-anastomosing type peculiar to this group and more readily recognized than described are usually abundant.

Pycnospores, whether on the host or in culture, also remain hyaline and non-septate until nearly or quite full size. Their walls are thick and glassy in appearance as in pycnospores of the tropical fungus often called *Diplodia natalensis*. Later they regularly become one-septate and light brown. There are no conspicuous longitudinal markings. These pycnospores are wide in proportion to their length, measuring $18-25 \times 12-17 \mu$, mostly $21-24 \times 15-16 \mu$. The conidiophores are very short, sometimes only 3μ , and the pycnospores often appear sessile. In stromatic characters, shape of asci, etc., this fungus does not differ significantly from related species already illustrated in this Journal.²

SEPTATE ASCOSPORES IN THE GENUS PHYSALOSPORA

The genus *Physalospora* is ordinarily considered as being characterized by one-celled hyaline ascospores. Continued study of fungi of this group results inevitably in the conviction that rigid adherence to these characters results in limitations so artificial as to be quite untenable. Over 50 years ago Ellis³ in discussing variability in what he then called "*Sphaeria quercuum*" called attention to the fact that brown biseptate ascospores were to be found in all the different forms then under discussion but not within the asci. He said, "They occur but sparingly it is true, but a careful and patient search is sure to reveal their presence."

The substantial truth of Ellis' observation has been many times confirmed. Indeed, it is the rule rather than the exception to find in slides containing old ascospores, a few spores with two cross walls characteristically placed approximately equidistant from the median line. This is true in all the species studied which are usually described as having hyaline one celled ascospores. The fungus under consideration differs in this respect from the species recognized as typical of *Physalospora* merely in the frequency and

² Stevens, N. E. Two species of *Physalospora* on citrus and other hosts. *Mycologia* 18: 206-217. 1926 (and earlier papers therein cited).

³ Ellis, J. B. Reply to Dr. M. C. Cooke's criticism of paper on "Variability of *Sphaeria quercuum* Sz." *Acad. Nat. Sci. Phila. Proceedings* 1879: 381-382. 1880.

regularity with which septation occurs in the ascospores and in the age of the spore at the time the septa develop. It can scarcely be seriously insisted that such a distinction is valid as a generic character.

SPECIMENS EXAMINED

Type or authentic specimens of the pycnidial stage of the following have been examined and seem to the writer identical with the fungus from Toronto. Slides of all of these have been deposited in the mycological collections of the Bureau of Plant Industry.

Sphaeria gallae Schw. on oak gall collected at Bethlehem, Pennsylvania. Excellent material with abundant pycnosporos from the original packet in the Schweinitz Herbarium at Philadelphia.

Sphaeropsis hyalina Berk. & Curt. on *Ribes rubra* from the Curtis collection. Our slides of this specimen contain only hyaline non-septate spores but their shape and thick walls warrant their inclusion here.

Sphaeropsis quercina Cooke & Ellis. A specimen collected on oak at Alcove, New York, March, 1893, distributed as No. 373, Shear, New York Fungi, determined by Ellis. Hyaline to light tan non-septate pycnosporos only but agreeing in size and appearance with the others here included.

Dothiorella quercina Cooke & Ellis distributed as Ellis' N. A. Fungi 3264. The specimen we have contains hyaline non-septate spores only.

Archer⁴ compared the morphological and cultural characters of this fungus from oak galls, oak twigs, and acorns. He was undoubtedly right in insisting (p. 38) that there are no valid distinctions between these fungi which were maintained as distinct species by Schweinitz, Starbäck and later writers. The oak twig fungus studied by Miss Ingram⁵ and called *D. longispora* Ellis & Ev. by her seems, however, quite distinct.

In none of the specimens above listed have ascospores been discovered. The portion of Schweinitz' specimen of *Sphaeria*

⁴ Archer, W. A. Morphological characters of some Sphaeropsidales in culture. Ann. Myc. 24: 1-78. 1926.

⁵ Ingram, D. E. A twig blight of *Quercus Prinus* and related species. J. A. R. 1: 339-346. 1914.

glandicola Schw. found in the Michener collection contains numerous ascospores, still hyaline mostly $12-15 \times 28-33 \mu$ and an occasional older biseptate ascospore.

The portion of Schweinitz' specimen examined by Starbäck contained pycnosporos the size of which is given by him as $12-14 \times 15-20 \mu$ and thus from their shape obviously belong to this species. This specimen as the oldest named ascospore specimen seems to be properly considered the type specimen and the name of this species to be properly indicated as *Physalospora glandicola* (Schw.). Part of the type specimen on acorns collected by Schweinitz at Bethlehem, Pennsylvania, is in the Michener Herbarium, Bureau of Plant Industry, United States Department of Agriculture.

PHYSALOSPORA GLANDICOLA (Schw.) N. E. Stevens.

Synonyms based on examination of type or authentic specimens.

Perithecia and pycnidia

Sphaeria glandicola Schw. p. 214. Syn. fung. Amer. Bor. 1832.

Pycnidia only

Sphaeria gallae Schw. p. 207. do.

Sphaeropsis hyalina Berk. & Curt. 1874. Grevillea 2: 179. 1874.

Sphaeropsis quercina Cooke & Ellis. 1876. Grevillea 5: 32. 1876.

Dothiorella quercina (Cooke & Ellis) Ellis & Ev. N. A. Fungi 3264. 1895.

Synonyms based on descriptions only.

Sphaeropsis gallae (Schw.) Berk. & Curt. Sacc. Syll. 3: 300. 1884.

Dothiorella gallae (Schw.) Starb. Bih. Sv. Vet. Akad. Handl. 19 (3): 65. 1894.

Dothiorella glandicola (Schw.) Starb. do. 19 (3): 64.

Dothiorella gallae (Schw.) Ellis & Ev. N. Am. Pyren. 745. 1892.

Sphaeropsis gallae (Schw.) Archer. Ann. Myc. 24: 37. 1926.

Botryodiplodia gallae (Schw.) Pet. & Sydow. Gatt. Pyren. 1: 152. 1926.

Pycnidia simple or compound in black erumpent stromata, on oak bark, mostly 1 to 2 mm. in diameter, pycnosporos at first one-celled and hyaline, with a thick glassy wall, becoming light brown and septate with no obvious striations; $12-17 \times 18-25 \mu$, mostly $15-16 \times 21-24 \mu$.

Perithecia in stromata similar to the pycnidia or in the same ones. Variable in size up to 200 or 225μ in diameter. Asci regularly eight-spored. Spores hyaline and non-septate later becoming light brown and usually two septate; $12-16 \times 28-35 \mu$, mostly $14-15 \times 30-33 \mu$.

U. S. DEPT. AGRIC.,
WASHINGTON, D. C.

A NEW HOLLYHOCK RUST¹

J. J. TAUBENHAUS AND WALTER N. EZEKIEL

(WITH 3 TEXT FIGURES)

The common hollyhock rust caused by *Puccinia Malvacearum* is not known to occur in the Southern Gulf States, nor has it yet been found in Texas on any of the malvaceous plants. It was therefore of great interest when, in May, 1932, specimens of a hollyhock rust were received from Goliad (Goliad County), Texas. A number of plantings of hollyhocks near Goliad had been seriously damaged by this disease. These specimens showed numerous rust pustules on all parts of the leaves, petioles, blooms, seed bracts, and even the seeds. Most of the sori appeared to result from secondary infection and were formed in concentric circles surrounding the older, central sori (FIG. 1, 2). The pustules were covered by a thin, uniform mildew-like growth. This superficial growth resembled the fungus parasites sometimes seen on rust pustules, but was found instead to consist of the characteristic promycelia and sporidia from the germinating teliospores. It will be noted that the symptoms of this rust were different from those of the common hollyhock rust which is widespread in many of the Northern states. Pustules of *Puccinia Malvacearum* are ordinarily formed singly within a circular area of dead and discolored tissue, and secondary pustules are formed only occasionally, in the immediate vicinity of the original rust sorus.²

The pustules of the new rust contained typical teliospores, mostly of the mesospore or one-celled type. The remaining spores were two-celled (FIG. 3) but distinctly different from the two-celled teliospores of *P. Malvacearum*. Most of the teliospores had germinated in place and produced typical promycelia with sporidia (FIG. 3). The sporidia germinated readily in ordinary

¹ Published with the approval of the Director as contribution no. 266, Technical Series, of the Texas Agricultural Experiment Station.

² Taubenhause, J. J. A contribution to our knowledge of the morphology and life history of *Puccinia Malvacearum* Mont. Phytopath. 1: 55-62. 1911.

tap-water or in a decoction made from hollyhock leaves. The organism was identified as *Puccinia heterospora* Berk. & Curt.³ This rust is known to occur in the Bahamas, Costa Rica, Cuba, California, Guatemala, Jamaica, Porto Rico,⁴ St. Thomas, and St. Croix. Seymour⁵ mentions 17 different malvaceous hosts

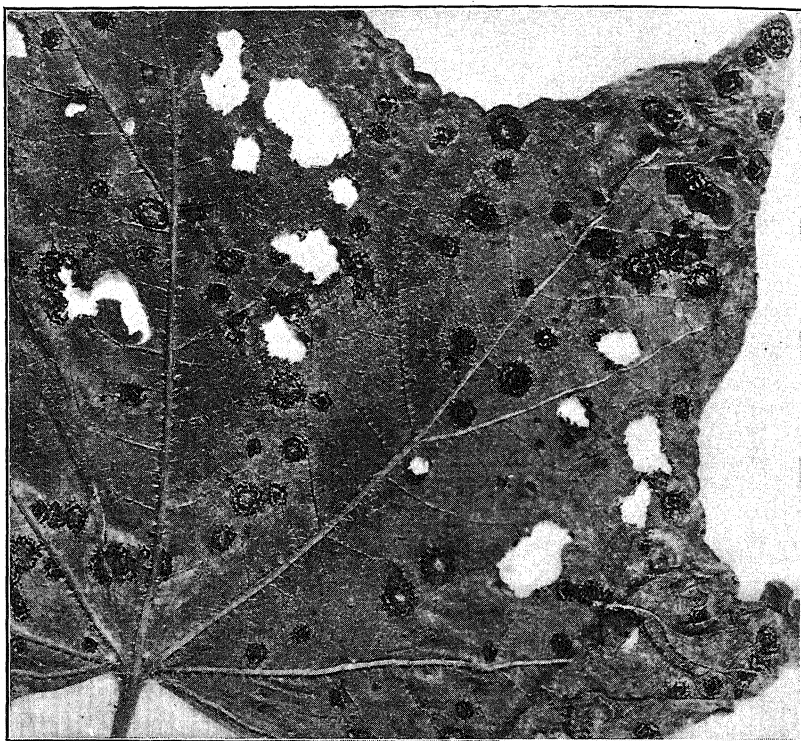


FIG. 1. Hollyhock rust caused by *Puccinia heterospora*, typical sori.

which are attacked by *Puccinia heterospora*, but not the hollyhock. In Texas, the writers have previously found *Puccinia heterospora* on different species of *Sida*. However, despite the senior writer's

³ The writers are indebted to Dr. H. S. Jackson and Dr. F. D. Kern for confirming the identification of this fungus.

⁴ Arthur, J. C. Uredinales of Porto Rico based on collections by F. L. Stevens. *Mycologia* 7: 238-239. 1915.

⁵ Seymour, A. B. Host index of the fungi of North America. Harvard University Press, Cambridge, Massachusetts. 1929.

continued interest in hollyhock diseases and frequent observations on hollyhock plants in different parts of the State, no rust had been found previously on hollyhocks. It therefore seems probable that the sudden outbreak of this rust on hollyhocks may be due to the appearance of a new physiologic form of the fungus.

Four normal hollyhock plants, growing in the garden of the senior writer at College Station, were used for inoculations during May, 1932. Two plants were sprayed with a heavy suspension

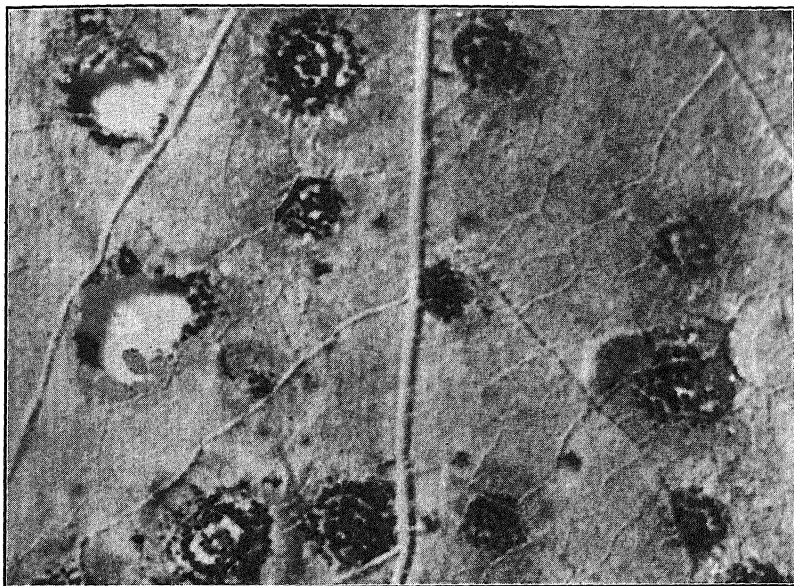


FIG. 2. Same as fig. 1 but enlarged about four times.

of sporidia washed from pustules on infected hollyhock leaves secured from Goliad, Texas, and two plants were inoculated by placing freshly-infected leaves from the same source in contact with the leaves of the plants to be inoculated. The plants were watered copiously and covered for 24 hours with bell jars lined with moist filter paper. Within three weeks, numerous typical rust pustules developed on all these inoculated plants. Four hollyhock plants growing on the other side of the house had been left as checks, and remained free from the rust. Under the microscope, the teliospores from the sori of the artificially inoculated

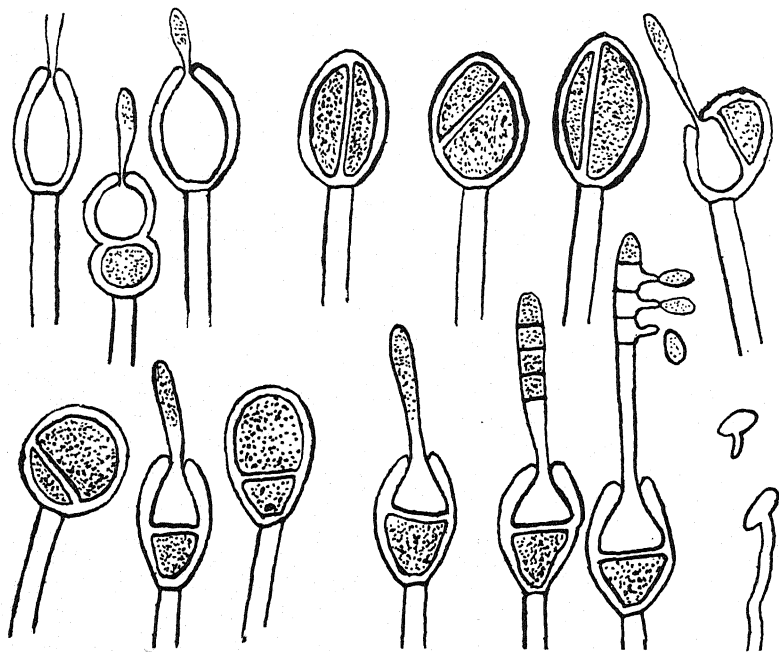


FIG. 3. One- and two-celled teleutospores of *P. heterospora*, some of these in various stages of germination.

plants appeared typical of *Puccinia heterospora*. These inoculations proved definitely that the autoecious rust, *Puccinia heterospora*, can attack hollyhocks.

COLLEGE STATION,
TEXAS.

INOPERCULATE CHYTRIDIACEOUS ORGANISMS COLLECTED IN THE VICINITY OF ITHACA, N. Y., WITH NOTES ON OTHER AQUATIC FUNGI

F. K. SPARROW, JR.

(WITH PLATE 49 AND 1 TEXT FIGURE)

An account has been given in a previous paper (8) of the operculate members of the Chytridiales collected in the vicinity of Cornell University in 1931-32. The present one enumerates those members of this order found in the same region, which discharge their zoöspores after the deliquescence of one or more papillae. Notes on other aquatic fungi, including two operculate chytrids, collected in the vicinity of Ithaca, are also included.

In assembling the chytridiaceous fungi on the common character of their method of sporangial dehiscence, no relationship between them is implied. It is possible that the operculate or inoperculate character may be found to be a matter of some significance among certain families, but in the light of our present knowledge, it cannot be generally applied.

FUNGI COLLECTED

Inoperculate Chytrids

1. ? PLASMOPHAGUS *ÆDOGONIORUM* de Wildeman, Ann. Soc. Belge Micro. 19: 219. 1895. Parasitic in *Tribonema bombycinum*, Fall Creek, Forest Home; April, 1932.

The fungus, which consists of a single-celled, sac-like structure, 20-23 μ long by 8-11 μ in diameter, almost completely fills the abnormally swollen and elongated algal cell (TEXT FIG. 1, 1). The walls of the fungus are, however, distinct from those of the host. At maturity, the fungous protoplasm is divided into a large number of zoöspores. The latter are discharged upon the deliquescence of a single papilla formed on the sporangium, which protrudes through the wall of the host. The zoöspores are posteriorly uni-

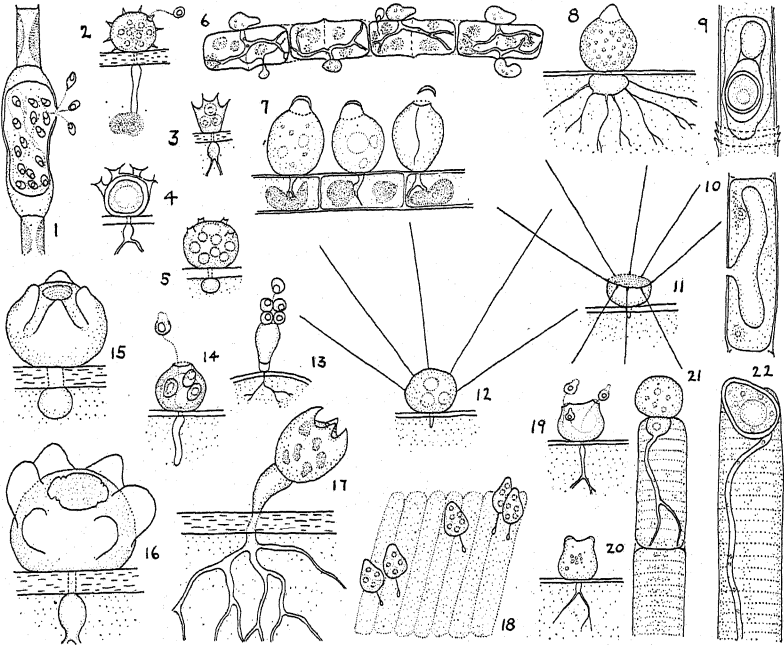


FIG. 1. 1. ? *Plasmophagus* *Ædogoniorum*, discharging sporangium in a hypertrophied cell of *Tribonema*; $\times 600$. 2. *Phlyctidium spinulosum* n. sp., discharging sporangium on *Cladophora*; $\times 600$. 3. ? *Phlyctochytrium* sp. on *Cladophora*; $\times 600$. 4. *P. quadricorne*, resting spore, on *Cladophora*; $\times 375$. 5. *P. Zygne-matis*, mature sporangium on *Cladophora*; $\times 375$. 6. Chytrid parasitic on *Melosira*; $\times 375$. 7. *Chytridium papillatum* n. sp., immature and discharged sporangia on a filament of *Stigeoclonium*; $\times 760$. 8. Chytrid parasitic on *Spirogyra*; $\times 375$. 9. *Olpidiopsis* *Ædogoniorum*, resting spore and companion cell in *Ædogonium*; $\times 375$. 10. *O. Ædogoni-orum*, empty sporangium in cell of *Ædogonium*; $\times 375$. 11. *Chytridium chaetophilum*, discharged sporangium on *Ædogonium*; $\times 760$. 12. *C. chaetophilum*, undischarged sporangium on same host; $\times 760$. 13. *Podochytrium clavatum*, discharging sporangium on *Navicula*; $\times 600$. 14. *Phlyctidium Olla* n. sp., discharging sporangium on *Spirogyra*; $\times 375$. 15, 16. *Phlyctochytrium* sp., discharged sporangia, on *Cladophora*; $\times 692$. 17. Partially discharged sporangium of a chytrid on *Cladophora*; $\times 375$. 18. Chytrid parasitic on *Tabellaria*; $\times 600$. 19. *Phlyctochytrium biporosum*, discharging sporangium on *Spirogyra*; the branches of the rhizoidal system were only visible after tearing away the chloroplast of the host; $\times 375$. 20. *P. biporosum*, immature sporangium on same host, showing a rhizoidal system of a somewhat different nature; $\times 375$. 21. Chytrid parasitic on *Oscillatoria*; $\times 375$. 22. Resting spores of a chytrid found on the same host; $\times 375$.

ciliate, somewhat elongate, uniguttulate, and about 3μ long by 2μ in diameter. Further phases of the life history were not observed.

The organism resembles both *Olpidium* and *Pleolpidium* in the possession of an intramatrical, sac-like sporangium, without rhizoids, from which posteriorly uniciliate zoöspores emerge upon the deliquescence of a papilla. It further resembles *Pleolpidium* in its tendency to produce a marked hypertrophy of the infected host cell. However, it differs from this genus in that the walls of both host and parasite are distinct, not fused. *Plasmophagus* is scarcely, if at all, distinct from *Olpidium*, when one considers all the species of the latter genus. The chief points of difference, namely, that the thallus of *Plasmophagus* nearly completely fills the host cell, that it lacks a tube of discharge, and that it causes hypertrophy of the infected cell, are all exhibited by one or another undoubted species of *Olpidium*.

The writer is not convinced that the Ithacan fungus and that found by de Wildeman in France on *Ædogonium* are identical. However, in view of the lack of measurements of the type species and the scarcity of material in the present instance which precluded the possibility of cross-inoculation experiments, it has seemed best to refer the parasite of *Tribonema*, at least tentatively, to *P. Ædogoniorum*.

2. *OLPIDIUM ENTOPHYTUM* A. Braun, Monatsb. Berlin Akad. 1856: 589. Parasitic in the vegetative cells of *Spirogyra* sp. (?), Fall Creek, Beebe Lake; Oct. 1931.
3. *WORONINA POLYCYSTIS* Cornu, Ann. Sci. Nat. V. 15: 176. 1872. Parasitizing hyphae of *Achlya* spp. (?) growing on twigs; Slaterville Springs; Nov. 1931.
4. ? *PSEUDOLPIDIUM INCRASSATA* (Cornu) Fischer; Rabenh. Krypt.-Fl. 1⁴: 37. 1892. Parasitic in vegetative hyphae of *Achlya* sp., from soil at base of a liverwort; Cascadilla Gorge, Ithaca; August, 1931. Only the ellipsoid resting spores with their hyaline, undulating outer wall were observed.
5. *OLPIDIOPSIS SAPROLEGNIAE*, Cornu, l. c. p. 145. Parasitic in hyphae of *Achlya* spp., Fall Creek, Forest Home; August, 1931.

6. *O. OEDOGONIORUM* (de Wild.) Scherffel, Arch. Prot. 52: 108. 1925. In filaments of *Cedogonium* sp., Beebe Lake; Oct., 1931. The elongate, sac-like discharged sporangia, 50 μ long by 5–7 μ in diameter, each with a short, lateral exit tube were found in the host cells (TEXT FIG. 1, 10). Often in the same cells, associated with the sporangia were elliptical resting spores, 13 μ long by 10 μ in diameter. Each thick-walled spore possessed a nearly spherical companion cell, about 10 μ in diameter, adhering to its somewhat larger "oögonium" (TEXT FIG. 1, 9). No zoöspores were observed but according to Scherffel, these are biciliate.
7. *Phlyctidium spinulosum* sp. nov. Sporangium extramatrical, sessile, spherical or slightly ovoid, colorless, generally about 10 μ in diameter, covered with short, sharp spines 2 μ high; with a single, unbranched, slightly inflated rhizoid, 10 μ long by 3 μ in diameter; with a single, sub-apical pore through which the spherical, posteriorly uniloculate, uniguttulate zoöspores (usually about 8 in number), 3 μ in diameter, escape. Resting spores not observed.

Parasitic in *Cladophora* sp., Fall Creek, Forest Home; Nov., 1931. Rare, occurring with *Phlyctochytrium quadricorne* (de Bary) Schröt.

Zoosporangiiis globosis v. sub-globosis sessilibus, 10 μ dia., tunica spinulosa, basi filamentis inflatis irramosis munitis; zoosporis (circ. 8) globosis, 1-ciliatis, uniguttulatis, 3 μ dia.; papilla sub apicale praeditis. Spor. perduranti-bus ignotis.

Hab. in *Cladophora* sp., Ithaca, N. Y.

This is the only species of the genus (TEXT FIG. 1, 2) which does not possess a smooth-walled sporangium.

8. *Phlyctidium anatrosum* (Braun) comb. nov.

Syn. *Chytridium anatrosum* Braun, Monatsb. Berl. Akad. 1856: 588.

Rhizophidium anatrosum (Braun) Fischer, l. c. p. 104.

The broadly pyriform, smooth-walled, strongly arched, or re-flexed sporangia, 15–20 μ long by 5–7 μ in diameter, were attached to the host near their narrower end by a short, lateral, barely perceptible, knob-like, intramatrical peg (PLATE 49, FIGS. 4–7).

Emergence of the zoöspores seemingly took place through one, sometimes two pores, at either or both ends of the sporangium (PLATE 49, FIGS. 4, 6). In spite of intermittent observations for more than two months on sporangia, no cases of actual discharge of the zoöspores were observed. The latter were frequently seen, however, fully formed within the sporangia (PLATE 49, FIG. 8). They were spherical, $3-4\ \mu$ in diameter, and, in contrast to those found in inactive sporangia of other chytrids, did not seem to possess the usual prominent oil globules. In the many discharged and undischarged sporangia examined, no traces of an operculum attached to or lying in the immediate vicinity of a sporangium were observed. These nearly always can be found near plants of operculate species. There seems little doubt therefore, that the zoöspores are discharged in an inoperculate manner. Thick-walled, ovoid, extramatrical resting spores were described by Braun, but they were not observed in the present material.

This curious fungus was described but not figured by Braun, who found it on *Chaetophora*. It was later (1858) mentioned by Schenk (4) as parasitizing *Oscillatoria*. Since then the chytrid has apparently remained unobserved and no figures of it have apparently been heretofore published. From its intramatrical attachment, unobserved by Braun and Schenk, the fungus appears to be better placed, for the present, in *Phlyctidium* than in *Rhizophidium*.

The algal host seemed to be entirely unaffected by the presence of the fungus.

On *Stigeoclonium* sp., Bessemer, N. Y.; Jan. 1932.

9. **Phlyctidium Olla** sp. nov. Sporangium sessile, urn-shaped, smooth-walled, $13-15\ \mu$ high by $15-17\ \mu$ in diameter, with a broad apical papilla; intramatrical portion unbranched, inflated, about $2\ \mu$ in diameter by about $12\ \mu$ long; zoöspores emerging after the deliquescence of the papilla, ovoid, $5\ \mu$ long by $3\ \mu$ in diameter, posteriorly uniciliate, uniguttulate. Resting spores not observed.

Parasitic in *Spirogyra* sp., Beebe Lake, Ithaca; Nov. 1931.

Zoosporangii sessilibus ampullaceis, $13-15 \times 15-17\ \mu$, basi filamentis inflatis irramosis munitis; zoosporis ovoideis, $5 \times 3\ \mu$, uniciliatis, uniguttulatis. Sporibus perdurantibus ignotis.

Hab. in *Spirogyra* sp., Ithaca, N. Y.

In the shape of the sporangium this fungus (TEXT FIG. 1, 14) resembles *Rhizophidium sphaerocarpum* (Zopf) Fischer. However, the inflated character of the intramatrical system distinguishes it as a species of *Phlyctidium*. From other species of this genus the Ithacan fungus is also distinct. In the shape of its sporangium it approximates that found in *P. Chlorogonii* Serb., *Phlyctidium Eudorinae* Gim. (a species probably identical with Serbinow's fungus), and to a lesser extent, the incompletely known *P. Bumilleriae* Couch. All of these species, however, possess a bulbous or discoid intramatrical portion. Other species of *Phlyctidium* also possess well-marked characters which make them distinct from the form under consideration. The spherical or ellipsoidal sporangia of *P. laterale* possess one or more lateral papillae of discharge; those of *P. breviceps* (Atk.) Minden are attached to the host by a short, peg-like structure; the finger-like sporangia of *P. anomalum* Couch are attached to the host by a bulbous or discoid base. The two species of *Phlyctidium* previously discussed in this paper also exhibit individuality, *P. spinulosum*, by the character of its wall, and *P. anatrosum*, by the shape of its sporangium.

Attention might be called to what is possibly another species of *Phlyctidium*, distinct from all others by the possession, on the surface of its spherical sporangium, which was about 15μ in diameter, of a series of very tenuous, radiating hairs (PLATE 49, FIG. 12). The intramatrical portion of the fungus consisted of a stout, somewhat irregular, unbranched filament, slightly swollen at the point of contact of the inner wall of the host. This "haustorium" was about 40μ long by 8μ in diameter. No further phases of the organism, which was parasitic in a species of *Cladophora* collected in Beebe Lake in October, 1931, were observed. The nature of the intramatrical portion of this fungus which, because of its slight sub-sporangial swelling resembles a species of *Phlyctochytrium*, and because of the unbranched, inflated character of the remainder is *Phlyctidium*-like, well illustrates (as do *Phlyctochytrium biporosum*, *P. vernale*, and others) the rather dubious nature of the characters which at present separate *Phlyctidium* and *Phlyctochytrium* from *Rhizophidium*.

10. RHIZOPHIDIUM GLOBOSUM (Br.) Schröt. Krypt.-Fl. Schles. 3¹: 191. Parasitic in *Oscillatoria* spp., *Spirogyra* spp., Fall Creek, Forest Home; Aug.-Dec. 1931; *Navicula* sp., Lloyd Reservation; Nov., 1931.
11. RHIZOPHIDIUM CARPOPHILUM (Zopf) Fischer, l. c. p. 95. Resting spores and sporangia abundant in old water cultures, on oögonia and oöspores of *Saprolegnia* sp., *Achlya* spp. and *Monoblepharis macrandia*; Fall Creek, Forest Home; Nov.-April, 1931-2.
12. RHIZOPHIDIUM SPHAEROCARPUM (Zopf) Fischer, l. c. p. 95. On nematodes parasitized by *Harposporium*; Beebe Lake; March, 1932. The sporangia of this fungus, which the writer cannot distinguish morphologically from those found on Green Algae by Zopf, were spherical to urn-shaped, 17-20 μ in diameter, with a broad apical papilla and a slender, unbranched, intramatrical rhizoid. The zoöspores, which were about 4 μ in diameter, were discharged from the sporangium *en masse*, through a broad terminal pore, and were apparently imbedded in "slime" or surrounded by a vesicle (PLATE 49, FIG. 1). Ultimately, the mass became disorganized and the motionless spores, thus liberated, gradually became motile.
13. RHIZOPHIDIUM FUSUS (Zopf) Fischer, l. c. p. 99. Very common on *Melosira varians*, Fall Creek, Forest Home; at all times of the year.
14. RHIZOPHIDIUM GIBBOSUM (Zopf) Fischer, l. c. p. 102. Parasitizing *Navicula* sp., Bessemer, N. Y.; March, 1932. Only the peculiar, contorted, irregular sporangia, 30-45 μ long by 10-20 μ in diameter, were observed (PLATE 49, FIG. 13). According to Zopf, these possess an intramatrical rhizoidal system. The empty sporangium on the diatom shown on plate 49, fig. 13, is that of an undetermined chytrid.
15. RHIZOPHIDIUM SIMPLEX (Dang.) Fischer, l. c. p. 101. On dead colonies of *Pandorina*, Bessemer, N. Y.; March, 1932.
16. RHIZOPHIDIUM POLLINIS (Br.) Zopf, Abhandl. naturf. Gesell. Halle 17: 82. 1887. On pollen of *Pinus* used as "bait," Beebe Lake; Dec., 1931.

17. RHIZOPHIDIUM sp. Parasitizing *Spirogyra* sp., Bessemer, N. Y.; March, 1932.

The sporangia of this fungus were somewhat similar in shape to those of *R. sphaerocarpum*, but in contrast to that species possessed a smaller apical papilla (PLATE 49, FIG. 18). In its general aspect it also resembled the incompletely known *R. dubium* de Wild. One characteristic feature was the formation at the base of the sporangium at the point of attachment of the well-developed, ramifying rhizoidal system, of a conspicuous, glistening nodule. This body probably separated the intra- and extramatrix parts of the plant.

The behavior of the zoospores of this organism is of unusual interest. These bodies, which were 4–5 μ in diameter, spherical, and of the usual chytridiaceous, uniguttulate type, upon being discharged from the sporangium after the deliquescence of a single apical papilla, swarmed for several hours and then settled down on the wall of the *Spirogyra* in compact groups of 4–10 or more (PLATE 49, FIG. 20). Occasionally they occurred in groups of two or three and in these cases their subsequent development was followed with greater clarity.

Two adjacent spores of the same size, each produced upon germination the usual germ tube which penetrated the wall of the host and formed within, an intramatrix rhizoidal system of limited extent (PLATE 49, FIG. 16). It was soon evident, however, that one of these spores was increasing rapidly in size, whereas the other had apparently ceased to grow (PLATE 49, FIG. 15). The rhizoidal system of the larger plant continued to increase in stoutness and extent, while that of the smaller remained relatively undeveloped. Under favorable conditions for observation with a water immersion objective, there could be observed, within the larger thallus at the point of contact of the two plants a very definite, short, refractive tube which was seemingly formed by the smaller plant (PLATE 49, FIGS. 17, 22). The whole content of the smaller thallus which may be spoken of arbitrarily as the "male plant," was, with the exception of a single globule, discharged through this tube into the larger thallus. The receptive plant continued to increase in size and ultimately its extramatrix part became transformed into a thick-walled resting spore to

which the empty cyst of the male thallus—generally torn from its rhizoidal system—remained adherent (PLATE 49, FIGS. 15, 21). When mature, the resting spore was spherical or ellipsoidal, thick-walled, 11–14 μ in diameter, with a large oil globule in the content, and often surrounded by an outer, irregular, dark-brown incrustation, 1–3 μ thick. The adherent male cell was constantly 5 μ in diameter, colorless and smooth walled. Germination of the resting spores was not observed.

Because of the limited amount of material available, the above account is of necessity somewhat brief and incomplete. It is clear, however, that in the formation of the resting spore there is a definite process of fertilization which involves a transportation of material by means of a tube from one thallus to another. Furthermore the zoospores from which these two thalli were derived were indistinguishable from one another. In one instance, tubes of considerable length, similar to those found in *Zygorhizidium Willei* Löwenth. were observed on a few thalli (PLATE 49, FIG. 19). No further development took place in this instance.

That this conjugation of thalli is the only method whereby resting spores of *Rhizophidium* are formed does not, from the present state of our knowledge, appear probable. Extramatrical, thick-walled resting spores without adherent male cells, associated with sporangia of *Rhizophidium* have been known and frequently observed since Braun's time. They have been found many times by the writer. Whether or not this type of spore is simply a modified sporangium or a body formed after the copulation of planogametes, is not known. Zopf (l. c.) was unable to detect any evidence of such copulation in *R. pollinis*, a species in which such resting spores are formed in abundance. Seemingly, however, no serious effort has been made since then to verify this statement.

If only one species of fungus has been involved in each of the cases where resting spores have been reported in *Rhizophidium*, it is evident that in this genus we have either different types of resting spores, sexual and asexual in origin, or different processes of sexual reproduction which lead to their formation.

Scherffel (5) has described resting spores which closely resemble those of the present fungus. These, he conjectured, might belong to *Chytridium Confervae* (Willie) Minden, the non-sexual stage

of which he found on the same host (*Tribonema*). This same investigator has recorded other instances of chytridiaceous resting spores formed by a process of conjugation of thalli, and in one species, *Rhizophidium goniosporum* Scherf., the present writer is able to confirm his observations from material recently collected in Great Britain. More recently, Couch (2) has described in *Rhizophidium* sexually formed resting spores essentially like those of the present fungus, with which it may be identical. The sporangium of the Carolinian form was, however, multiporous. The finding of such resting spores in a "*Rhizophidium globosum*" type of chytrid is of unusual interest, for it is in this multiporous type that resting spores without companion cells have been most frequently found.

As the literature on the genus *Rhizophidium* is rather extensive and in the particular section to which the fungus under discussion belongs, in a chaotic state taxonomically, it has not been deemed desirable to refer the organism at this time to any described species.

18. PHLYCTOCHYTRIUM BIPOROSUM Couch, Jour. Elisha Mitchell Sci. Soc. 47: 254. 1932. Parasitic in *Spirogyra* sp. (?), Bessemer, N. Y.; March, 1932.

The sporangia of this fungus were sessile, smooth-walled, ovoid at first, but upon the formation of the discharge papillae became truncated at the apex and angular in outline; they varied from 8–13 μ in diameter by 10–12 μ in height. The two pores were formed on the upper part of the sporangium and while they were usually sessile, occasionally they were borne on the tips of short, diverging beaks. Through these pores, minute, posteriorly uniciliate, uniguttulate zoöspores about 2 μ in diameter, crept in an amoeboid manner (TEXT FIG. 1, 19). The intramatrical portion of the fungus was a branched or frequently unbranched rhizoidal system (TEXT FIG. 1, 20), which, because of the density of the host chloroplast, was of unknown extent. Resting spores were not observed. Just beneath the wall of the host there was generally visible a slight swelling of the fungous rhizoid. This swelling was at most barely perceptible, and in some instances was lacking. Resting spores were not observed, nor have they been recorded by Couch.

This species is probably identical with that incompletely described by de Wildeman as "*Chytridium rostellatum*" (*Rhizo-*

phidium rostellatum (de Wild.) Fischer). However, it would seem better to adopt the name given to the more completely described fungus. As was pointed out in the discussion of *Phlyctidium Olla*, the three genera *Phlyctidium*, *Rhizophidium*, and *Phlyctochytrium* are in need of a more clear-cut delimitation of generic characteristics. It seems, at least to the writer, a mere "splitting of hairs" to place this form in *Phlyctochytrium*, rather than *Rhizophidium*. Further, from Couch's description and figures, his fungus might be equally well placed in *Phlyctidium*.

19. *PHLYCTOCHYTRIUM ZYGNEMATIS* (Rosen) Schröt. E. & P. Nat. Pfl. 1¹: 79. 1892. Parasitic on *Cladophora* sp., Beebe Lake; Oct., 1931. The nearly spherical, sessile sporangium, about 17μ in diameter, possesses at its apex four inconspicuous, blunt, slightly notched teeth which surround the papilla of discharge. Within the host cell there is a spherical portion, about 7μ in diameter, which is seemingly devoid of rhizoids (TEXT FIG. 1, 5). No further phases in the life history of the fungus were observed.
20. *PHLYCTOCHYTRIUM QUADRICORNE* (de Bary) Schröt. l. c. p. 79. Common on filaments of *Cladophora* in all aquatic habitats in the vicinity of Ithaca throughout the year. This species, which resembles the preceding one, but which possesses four, prominent, deeply incised teeth, the apices of which are strongly divergent, occurs in dense clusters on the algal filament. The intramatrical portion varies from fusiform to spherical in shape. Extramatrical, thick-walled resting bodies, 15μ in diameter (TEXT FIG. 1, 4), were also observed and may possibly be the resting spores of this species.

Two other organisms, which apparently belong to the "Dentigera" group of the genus, were also observed on *Cladophora* in the vicinity of Ithaca. The first of these possessed somewhat cylindrical sporangia which tapered perceptibly towards the base (TEXT FIG. 1, 3), were $5-7\mu$ in diameter by 7μ in height, and possessed four, plain, diverging teeth. The intramatrical system was rhizoidal in character and emanated from a swollen, sub-sporangial portion. The zoöspores, 3-4 in number, which even

in the undischarged sporangium appeared spherical and uniguttulate, were not more than 3μ in diameter. The method of their discharge was not observed.

The second fungus was much larger and possessed broad, urn-shaped sporangia, $17-23\mu$ in diameter, on which were 4-6 coarse, solid, nodular or flange-like refractive outgrowths (TEXT FIG. 1, 15, 16). The intramatrical portion was pronouncedly spherical and the tube connecting it to the sporangium unusually stout. The zoöspores evidently escaped through the large circular, apical pore which was surrounded by the crown of nodules.

21. *PODOCHYTRIUM CLAVATUM* Pfitzer, Sitz. ber. Nieder-rh. Ges. Nat. 1870: 62. Parasitizing *Navicula* spp., Fall Creek, Forest Home, and Lloyd Reservation; Oct. 1931.

The pyriform sporangia, $8-11\mu$ high by 5μ in diameter, possessed a cup-like sterile base about 3μ in diameter, which rested on the host (TEXT FIG. 1, 13). Within the latter, from the tip of a needle-like penetration tube, a delicate, branched rhizoidal system was formed. The zoöspores, 3μ in diameter, posteriorly unciliate and uniguttulate, at maturity emerged after the deliquescence of an apical papilla, and formed a compact motionless mass at the mouth of the sporangium. After a few seconds, the zoöspores fell apart, initiated ciliary movement, and swam away. Motion of the spores before emergence from the sporangium could often be detected.

22. *ENTOPHLYCTIS CIENKOWSKIANA* (Zopf) Fischer, l. c. p. 118. Common on *Cladophora* spp., Ithaca, Forest Home; throughout the year.
23. *HARPOCHYTRIUM INTERMEDIUM* Atk. Ann. Myc. 1: 500. 1903. On filaments of *Achlya*, growing on twigs collected in Fall Creek, Forest Home; April, 1932. This species has been recently found in abundance in the same habitat on twigs collected at Cambridge, Eng.
24. *CLADOCHYTRIUM REPLICATUM* Karling, Am. Jour. Bot. 18: 526. 1931. Common on *Elodea* leaves, Fall Creek, Forest Home; Oct. 1931; also in decaying grass culms, Slaterville Springs; April, 1932.

In the material from Slaterville Springs, spiny resting spores, 15–17 μ in diameter, were found (PLATE 49, FIG. 3). Each possessed a somewhat thickened, colorless wall and within the contents a large, orange-brown oil globule. The surface of the spore was covered with slender, scarcely tapering spines, 5–7 μ in length. Repeated attempts to germinate these spores have thus far failed, but work is being continued on this point.

OPERCULATE CHYTRIDS

Three other operculate chytrids were encountered after the paper on this group of fungi collected in the vicinity of Ithaca had gone to press.

25. *Chytridium papillatum* sp. nov. Sporangium sessile, pyriform to lemon-shaped, smooth-walled, 10–11 μ high by 7–8 μ in diameter, with a prominent broad, apical papilla surmounted by a convex operculum; with a delicate, sparsely branched rhizoidal system of limited extent which arises from a stouter intramatrix sub-sporangial stalk; zoöspores posteriorly uniciliate, uniguttulate, about 3–4 μ in diameter. Resting spores not observed. Occurring in groups along filaments of *Stigeoclonium* sp., Bessemer, N. Y.; March, 1932.

In the shape of its sporangium and nature of its rhizoidal system (TEXT FIG. 1, 7), the organism is exactly similar to *Rhizopodium mamillatum* (Br.) Fischer. However, from the accounts of Braun, Sorokin, Dangeard (as *Chytridium asymmetricum*) and Couch, the last named fungus seems to possess an inoperculate method of zoöspore discharge. *Chytridium minus* Lacoste & Suring, while resembling the present organism in the shape of its sporangium, possesses, from the figures given, a peculiar, flat-topped papilla. As no account of zoöspore discharge is given, further comparison is impossible. All other species of the genus are unlike the present fungus in the shape of the sporangium and nature of the rhizoidal system. Whether or not the similar-appearing fungus found by Pringsheim (reported by Braun) on *Stigeoclonium* was a *Chytridium* or a *Rhizopodium* cannot now be determined as no discharge of the zoöspores was observed.

Zoosporangii sessilibus pyriformibus vel limoniformibus, $10-11 \times 7-8 \mu$, apice umbonatis, operculo dehiscentibus; parte subsporangiale crassa rhizoideis paucis sparse ramosis praeditis; zoosporis 1-ciliatis, uniguttulatis circ. $3-4 \mu$ dia. Sporulis perdurantibus ignotis.

Hab. in *Stigeoclonium* sp., Bessemer, N. Y.

26. *CHYTRIDIUM CHAETOPHILUM* Scherffel, Arch. Prot. 53: 45.

1925. Syn. *Rhizophidium von Mindenii* Valkanov, Arch.

Prot. 73: 363. 1931.

The extramatrix, sessile, spherical sporangia, $8-10 \mu$ in diameter, are covered by very long setae (TEXT FIG. 1, 12). The intramatrix portion of the fungus consists of a short peg which barely penetrates the host cell. The latter, in most cases, seems unaffected by the presence of the adherent organism. Occasionally, empty sporangia are seen, the whole upper half of which has dehisced (TEXT FIG. 1, 11). Whether this type of dehiscence can be considered comparable to that found in other species of the genus, the writer is at present not prepared to state. It may possibly be only a disintegration of the wall material. Scherffel, who saw the discharge of the zoospores, states that in addition to a splitting of the wall of the sporangium, the zoospores may be set free by a gelatinization of a basal part of the sporangium. Extramatrix resting spores $7-10 \mu$ diameter, exactly similar to the sporangia but with a pronouncedly thickened wall, were occasionally observed in the present material. Scherffel has described extramatrix ones provided with short setae and a companion cell as typical for the species. The type found associated with the present fungus he has described as *Rhizophidium setigerum* Scherf.

It is possible that *C. chaetophilum* may be referable in the future to the genus *Rhizophidium*. The form described by Valkanov as *Rhizophidium von Mindenii* is without doubt identical with Scherffel's fungus.

27. *Chytridium perniciosum* sp. nov. Sporangium extramatrix, sessile, smooth walled, spherical at first, becoming broadly pyriform, with a prominent apical, solid operculum which, upon discharge of the zoospores remains attached to the sporangium and often falls back into place, covering the orifice (PLATE 49, FIG. 9); $10-16 \mu$ high by $12-23 \mu$ in

diameter; zoöspores spherical, posteriorly unicilate, uniguttulate, $3-4\ \mu$ in diameter; intramatrix portion a system of stout, branching rhizoids. Resting spores spherical, intramatrix, with a smooth, somewhat thickened wall, and one or more large oil globules (PLATE 49, FIG. 10); $11-16\ \mu$ in diameter.

Parasitic on *Navicula* sp., Bessemer, N. Y.; March, 1932.

Zoosporangii sessilibus primo globosis dein valde piriformibus, $10-16\ \mu \times 12-23\ \mu$, basi filamentis ramosis, apici operculo solido adherente praeditis; zoosporis globosis 1-ciliatis uniguttulatis $3-4\ \mu$ dia. Spor. perdurantibus globosis, membrana crassa, uni- vel multiguttulatis, $11-16\ \mu$ dia.

Hab. in *Navicula* sp., Bessemer, N. Y.

Occasionally large sporangia, about $30\ \mu$ high by $35\ \mu$ in diameter, were observed. Other sporangia, ovoid, pyriform or irregular in shape, with very thick walls and a horn-like operculum were also found (PLATE 49, FIG. 11). These may possibly be abnormal specimens of *C. perniciosum*. It might be noted that the fungus was an extremely virulent parasite and destroyed within a few days nearly all of the diatoms present in the dish. After being attacked by the fungus, the chloroplasts of the alga rapidly became discolored and desiccated. In immature sporangia, the operculum often appeared invaginated. Such a condition has also been observed in *Nowakowskiella*.

Chytridium perniciosum appears to be distinct from other undoubted members of the genus which possess somewhat similarly shaped sporangia. *C. sphaerocarpum* Dang. and *C. inflatum* Spar., both possess a thin-walled operculum; they further differ from *C. perniciosum* in the nature of their intramatrix system, that of the first-named being delicate and sparsely branched, the second, inflated in character. *Chytridium Olla* Br., *C. breviceps* Br. and *C. acuminatum*¹ (possibly a small form of *C. Olla*) all possess an urn-shaped sporangium and a strongly umbonate operculum. *Chytridium pyriforme* Reinsch, has pyriform sporangia which, in

¹ Scherffel (6) has redefined this species to include a form with urn-shaped sporangia, umbonate operculum, and a spherical, intramatrix base. Braun, however, in his original description of *C. breviceps*, states that it differs from *C. Olla* in its smaller size and in the possession of a "sehr kurzen rundlichen Wurzelfuss. . . ." It is probable, therefore, that Scherffel's fungus, termed *C. acuminatum*, is closer to *C. breviceps*.

contrast to those of *C. perniciosum*, taper towards the base. The empty, broadly urn-shaped, wide-mouthed sporangium of *C. lateoperculatum* Scherf. possesses too broad an exit pore and too flat an operculum to be confused with the present fungus. Further, the pyriform, operculate sporangia, with a short tube of discharge, found by Scherffel in decaying leaves of *Typha*, and referred by him to *Chytridium* (*Rhizophidium*) *xylophilum* Cornu, almost certainly belong to *Nowakowskiella elegans* (Now.) Schröt., a fungus very commonly found in such a habitat. However, as no rhizoidal system was observed, the identity of this particular organism must remain somewhat doubtful.

CHYTRIDS OF DOUBTFUL AFFINITIES

In addition to the aforementioned forms, several chytridiaceous fungi were found in the region, which could not be identified, as certain critical points in their life history were not observed.

A very small parasite of *Tabellaria*, possessing pyriform sporangia, $7\ \mu$ long by $5\ \mu$ in diameter, and a short slender extramatrical stalk which terminated in a refractive, intramatrical granule, was found in Fall Creek at Forest Home, in October, 1931 (TEXT FIG. 1, 18). Four to six uniguttulate zoöspores, about $3\text{--}4\ \mu$ in diameter, were found in each sporangium, but the method of their discharge was not observed.

Filaments of *Oscillatoria* sp., collected in the same creek in October, 1931, were, after several weeks in the laboratory, parasitized by a chytridiaceous fungus, the sporangia of which were extramatrical, spherical, about $12\ \mu$ in diameter, and possessed a sub-sporangial, intramatrical, spherical swelling about $6\ \mu$ in diameter. The sporangium rested on the terminal cell of the algal filament (TEXT FIG. 1, 21). Within the *Oscillatoria* a stout, sparingly branched rhizoidal system was found, which penetrated a considerable number of cells of the host. The contents of the latter became grey and disorganized upon the incursion of the fungus. Pyriform, thick-walled, seemingly intramatrical resting spores, $18\ \mu$ long by $8\text{--}16\ \mu$ in diameter (TEXT FIG. 1, 22) were found in the same lot of material and may possibly belong to the organism previously described.

On filaments of *Melosira varians*, collected in Fall Creek in August, 1931, another virulently parasitic chytrid was observed.

The sporangia were pyriform, 3–5 μ high by 7–10 μ in diameter, the long axes being parallel with that of the algal filament (TEXT FIG. 1, 6). Within the host cell a relatively stout, branched system of rhizoids was formed by the fungus. The latter caused discoloration and disintegration of the *Melosira* chloroplasts.

Another chytrid, possibly identical with *Rhizophidium digitatum* Scherf., was observed on a filament of *Cladophora* from Beebe Lake, collected in November, 1931. The broadly oval sporangium, 20 μ long by 7–10 μ in diameter, possessed a crown of four, coarse, plain, hollow teeth. The sporangium was not sessile but was borne on an inflated, extramatrix filament which was contiguous with an intramatrix, stout, ramifying rhizoidal system (TEXT FIG. 1, 17). The contents of the sporangium which were apparently dead, bore evidences of zoospore initials. The circular exit pore was clearly visible within the crown of teeth. As no other plants were found, nothing further could be determined about the fungus. Plants with extramatrix, subsporangial portions have been figured by Rosen in the cases of *Phlyctochytrium Zygnematis* and *P. dentatum*, and by Scherffel for *Rhizophidium digitatum*.

A fifth chytrid of doubtful affinities was observed in *Spirogyra*, collected at Slaterville, N. Y., in March, 1932. The extramatrix sporangia were broadly ovoid, symmetrical, 10–11 μ in diameter by 10–20 μ high, and possessed a broad, prominent, apical papilla. Within the host cell a sub-spherical, somewhat flattened swelling, 5–10 μ in diameter, was formed, from the whole surface of which numerous branched rhizoids emanated (TEXT FIG. 1, 8). No further points in the life history were observed.

OTHER AQUATIC FUNGI COLLECTED

BLASTOCLADIALES

28. BLASTOCLADIA PRINGSHEIMII Reinsch, Jahrb. Wiss. Bot. 11: 291. 1878. Very common on submerged apples and twigs, Fall Creek, Forest Home; pool on golf course; Lloyd Reservation; throughout the year.
29. BLASTOCLADIA GLOBOSA Kanouse, Am. Jour. Bot. 14: 298. 1927. On submerged apples, occurring with the previous species. In contrast to *B. Pringsheimii*, this species forms minute pustules on the surface of the fruit.

MONOBLEPHARIDALES

30. *MONOBLEPHARIS SPHAERICA* Cornu, Bull. Soc. Bot. Fr. 18: 59. 1871; Ann. Sci. Nat. V. 15: 82. 1872. On twigs of all types, Fall Creek, Forest Home, throughout the year. A more extensive account of this and other species of the order collected in the vicinity of Ithaca and elsewhere has been given in a recent paper by the writer (9).
31. *MONOBLEPHARIS POLYMORPHA* Cornu, l. c. 1871 p. 59; l. c. 1872, p. 83. Common on twigs of various types, Fall Creek, Beebe Lake; throughout the year.
32. *MONOBLEPHARIS MACRANDRA* (Lagerh.) Woronin, Mém. Acad. Imp. Sci. St. Pet. VIII. 16: 13. 1904. Occurring with *M. sphaerica*.
33. *MONOBLEPHARIS MACRANDRA* var. *LAEVIS* Spar. Ann. Bot. 47: 531. 1933. On fruits of *Rosa* sp., Fall Creek; April, 1932.
34. *MONOBLEPHARIS REGIGNENS* Lagerh. Bihand till Sv. Vet. Akad. Handl. 25³: 39. 1900. On twigs of various types, vicinity of Ithaca; throughout the year.
35. *MONOBLEPHARIS OVIGERA* Lagerh. l. c. p. 39. On twigs, occurring with the previous species.
36. *GONAPODYA PROLIFERA* (Cornu) Fischer, l. c. p. 382. Very common on submerged fruits and twigs, Fall Creek; Lloyd Reservation; throughout the year.
37. *GONAPODYA POLYMORPHA* Thaxter, Bot. Gaz. 20: 481. 1895. Occurring with the previous species, but more commonly on twigs.

SAPROLEGNIALES

38. *APHANOMYCOPSIS BACILLARIACEARUM* Scherffel, Arch. Prot. 52: 14. 1925. Parasitic in *Pinnularia* sp., Fall Creek, Forest Home; Oct., 1931.

This organism has recently been described from Hungary by Scherffel. The Ithacan fungus consisted of a simple, slightly inflated, unbranched, intramatrical tube, 6–8 μ in diameter, and a slightly narrower evacuation tube, 10–20 μ long. At the orifice of the latter were clustered 5–6 cystospores, 10 μ in diameter. Where the evacuation tube passed between the two valves of the

diatom, its walls were considerably thickened (PLATE 49, FIG. 14). This structure has been termed the "Spreizapparat" by Scherffel, and is formed by other filamentous Phycomycetes which inhabit diatoms.

Emergence of a laterally biciliate zoöspore from each of the cystospores has been noted by Scherffel. Although it was not observed in the present material there is no reason to suppose that it is lacking. The secondary zoöspores observed by Scherffel were 10–12 μ long by 7–8 μ in diameter. Branching of the thallus and an intramatrical oogonium with one or two apandrous, saprolegniaceous oöspores were also observed by Scherffel.

The genus is said to differ from *Aphanomyces* "... durch das Fehlen eines differenzierten Zoosporangiums und durch das rudimentäre, mehreiige Oogonium."

39. *ECTROGELLA BACILLARIACEARUM* Zopf, Nova Acta Leop-Carol Akad. 47: 175, Amend. Scherffel (l. c.). In *Pinnularia* sp., Fall Creek, Forest Home; Oct., 1931.
40. *ECTROGELLA MONOSTOMA* Scherffel, l. c. p. 8. 1925. In *Pinnularia* sp., Fall Creek, Forest Home; Oct., 1931. The broad thallus of this fungus, with a single tube of discharge, was found occurring in the some lot of material with the previous species. In neither case was the evacuation of the cysts of the primary spores observed.

It will be recalled that Zopf figured posteriorly uniciliate zoöspores as typical for *Ectrogella*. Scherffel has figured, in what all other respects is a fungus similar to Zopf's *E. bacillariacearum*, laterally biciliate zoöspores emerging from the primary cysts. The same type of discharge has been noted by him in *E. monostoma* and several other species assigned to the genus. This change in the concept of *Ectrogella* has shifted it from the Chytridiales to the Saprolegniales where, if Scherffel's observations are supported by further investigation, it undoubtedly belongs.

41. *APHANOMYCES EXOPARASITICUS* Couch, Jour. Elisha Mitchell Sci. Soc. 41: 213. 1926. Parasitizing filaments of *Achlya* sp., growing on twigs collected at Slaterville Springs; March, 1933.

42. *APHANOMYCES PHYCOPHILUS* de Bary, Jahrb. Wiss. Bot. 2: 179. 1860. Parasitic on *Spirogyra* sp., Beebe Lake; Nov., 1931. The fungus previously described from *Nitella* by the writer (7) and assigned to this species, is too small and delicate to be identical with *A. phycophilus*. Further, the thin-walled, slender, sharp-pointed oogonial spines of the *Nitella* parasite are quite different in character from the thick-walled, blunt, rounded ones of the present species.
43. *APHANOMYCES NORVEGICUS* Wille, Skr. Vid.-Selsk. Christiania. 1899³: 9. Occurring with the previous species.
44. *SOMMERSTORFFIA SPINOSA* Arn. Flora 116: 109. 1923. Among filaments of *Cladophora*, together with *Zoöphagus insidians*, capturing various members of the *Rotiferae*. Fall Creek, Forest Home; Oct., 1931.
45. *THRAUSTOTHECA CLAVATA* (de Bary) Humphrey, Trans. Amer. Phil. Soc. 17: 130. 1893. Common in soil, often occurring with *Nowakowskiella elegans*, Ithaca; throughout the year.

LEPTOMITALES

46. *APODACHLYA* ² *BRACHYNEMA* (Hild.) Prings. Ber. Deutsch. Bot. Gesell. 1: 289. 1883. Common on submerged apples, Fall Creek, Forest Home; Lloyd Reservation; throughout the year.
47. *APODACHLYA PIRIFERA* Zopf, Nova Acta. Leop.-Carol 52: 362. 1888. On submerged Birch twigs, Arnott Forest, August, 1931.
48. *RHIPIDIUM AMERICANUM* Thaxter, Bot. Gaz. 21: 327. 1896. Common on submerged apples and fruits of *Crataegus*, Fall Creek, Forest Home; Lloyd Reservation; throughout the year.

ANCYLISTALES

49. *MYZOCYTIUM PROLIFERUM* Schenk, Über das Vorkommen contract. Zellen im Pflanzenreich 1858: 10. In *Mougeotia* sp. and *Spirogyra* sp., Beebe Lake; Dec. 1931.

² *Apodachlya punctata* Minden, was found in abundance on twigs of *Fraxinus* at Arlington, Mass., in May, 1932.

PYTHIALES

50. ZOÖPHAGUS INSIDIANS Sommerstorff, Oest. Bot. Zeits. 61: 361. 1911. Occurring with *Sommerstorffia spinosa*.
51. PYTHIOGETON TRANSVERSUM Minden, Falk, Myc. Untersuch. Ber. 2: 242. 1916. Saprophytic on twigs of *Fraxinus*, Fall Creek, Forest Home; throughout the year.

What is seemingly a globose variety of this species has been encountered both in the vicinity of Ithaca and in New Hampshire. The mycelium is slender, $2-4\ \mu$ in diameter, often markedly thick-walled, and moderately branched. Terminal, or occasionally intercalary, globose sporangia, $35-40\ \mu$ in diameter are profusely formed. Occasionally, on the same hyphal complex on which globose sporangia are borne, an isolated bursiform one, entirely similar to that figured by Minden as typical for the species, occurs. These, while varying somewhat in size, and becoming successively smaller with proliferation, are generally about $40\ \mu$ long (exclusive of the tube of discharge which is generally about $10\ \mu$ in length) and about $10\ \mu$, expanding to $23-25\ \mu$ in diameter. Often, the sporangia are intercalary. Sporangial germination was only partially observed, and that in but one instance. When first seen, the long vesicle was rapidly deliquescing, and the slightly irregular protoplasmic mass was becoming more rounded in shape (PLATE 49, FIG. 23). The latter was about five times farther removed from the mouth of the discharge tube than depicted in the drawing. Practically no motion of the protoplasmic mass was evident until the spores had reached a relatively advanced state of maturity (PLATE 49, FIG. 24). They were of the laterally biciliate type, somewhat similar to those of *Pythium*, but more rounded, and were about $18\ \mu$ long by $12\ \mu$ in diameter. Attempts to cultivate the fungus on artificial media were unsuccessful.

52. PYTHIOMORPHA GONAPODIOIDES Petersen, Bot. Tidsk. 29: 391. 1909. Common on twigs of *Fraxinus*, Beebe Lake; Fall Creek; throughout the year.
53. PYTHIUM TENUE Gobi, Script. Bot. Hort. Univ. Imp. Petro. 15: 211. 1899. Parasitic in *Vaucheria sessilis*, Bessemer; March, 1932. The "light and dark" areas noted in the

- mycelium by Gobi and Matthews (3) are apparently caused by elongate globules of oil with which the hyphae abound.
54. *PYTHIUM GRACILE* Schenk, sensu lat. Matthews (l. c.). Parasitic in *Spirogyra* spp., Beebe Lake; Fall Creek; August-Dec., 1931.
55. *PYTHIUM DICTYOSPORUM* Racib. Bull. Int. Acad. Sci. Cracovie 1891: 283. Parasitic in *Spirogyra* sp., Beebe Lake; Jan., 1932.

FUNGI IMPERFECTI

56. *HARPOSPORIUM ANGUILLULAE* Lohde. Parasitic on a Nematode, Beebe Lake; March, 1932; associated with *Rhizopodium sphaerocarpum*. As was suggested by Zopf (10), this fungus is undoubtedly similar to the supposed chytridiaceous fungus, *Polyrhina multiformis* Sorokin. The conidia are sickle-shaped and are borne on an extramatrical conidiophore (PLATE 49, FIGS. 1, 2). Zopf has published an exhaustive account of the fungus and the present material yielded no further points of interest. The organism has been reported from Canada by Bisby, Buller, and Dearnness (1).

SUMMARY

This paper concludes the account of the aquatic fungi found by the writer in the vicinity of Cornell University. The total number of aquatic fungi collected was 76, of which 64 are reported in this paper and 12 in a previous one (8). All but one of those reported (*Harposporium*, a member of the Imperfecti) were Phycomycetes. Among the latter are included two new genera and ten new species of chytrids and one new variety of *Monoblepharis*.

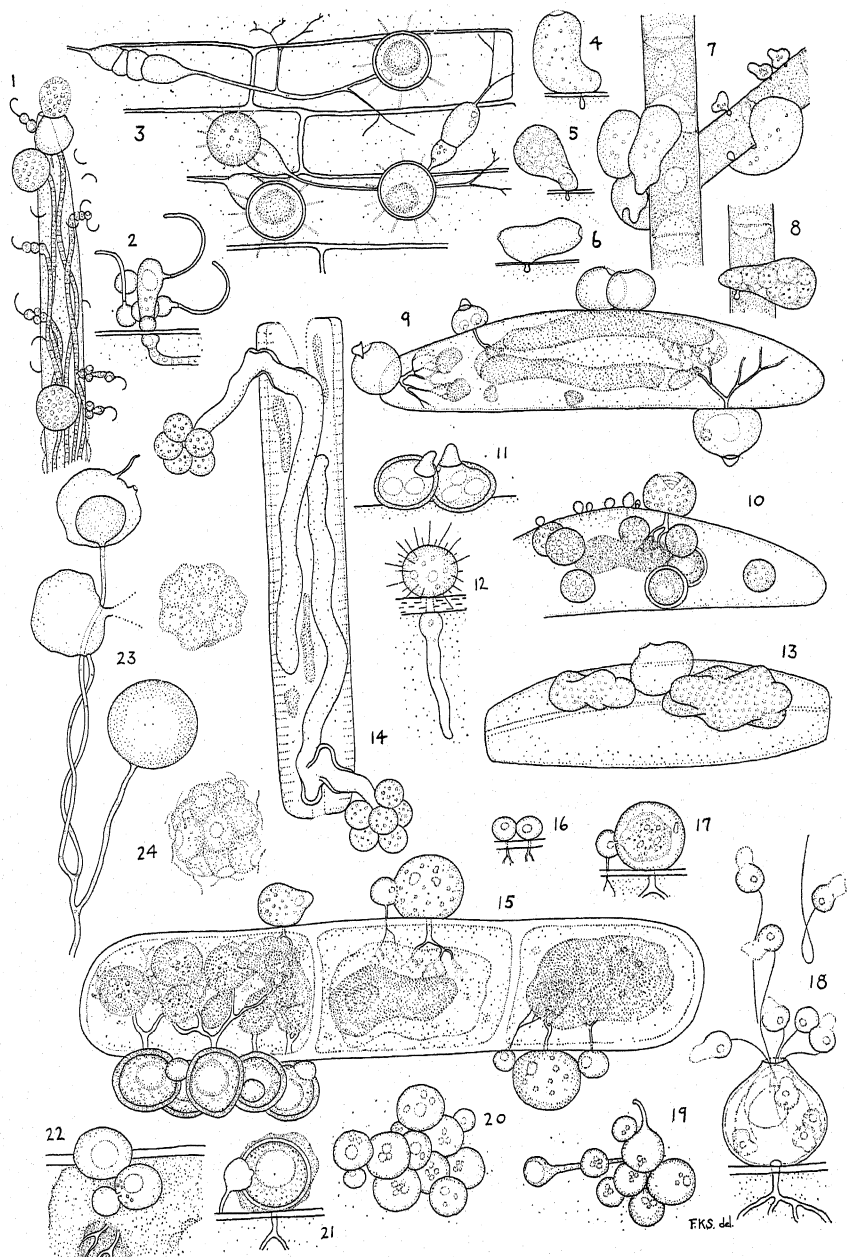
The writer wishes to thank Mr. F. T. Brooks, F.R.S., for his kindness in reading over the manuscript.

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BOTANY SCHOOL, CAMBRIDGE UNIVERSITY.

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EXPLANATION OF PLATE 49

All figures were drawn with the aid of the camera-lucida from living material. The approximate magnifications are given in each instance.

Fig. 1, *Rhizophidium sphaerocarpum* and *Harposporium Anguillulae* on a dead Nematode. A discharging sporangium of *Rhizophidium* is shown at the tip of the Nematode, $\times 260$; Fig. 2, Extramatrical conidiophore of *Harposporium* bearing immature conidia, $\times 600$; Fig. 3, *Cladochytrium replicatum*, spiny resting spores found in grass culm, $\times 375$; Figs. 4-8, *Phlyctidium anatrosum*. All $\times 692$, Figs. 4-6, illustrating various shapes of sporangium, Fig. 7, group of sporangia in various stages of development on *Stigeoclonium*, Fig. 8, sporangium with fully formed zoöspores.

Figs. 9-11. *Chytridium permiciosum* Sparrow, on *Navicula*; all $\times 375$, Fig. 9, group of discharged sporangia, Fig. 10, intramatrical resting spores, an immature sporangium with invaginated operculum, and a group of germinating zoöspores. Fig. 11, two abnormal sporangia with large, horn-like opercula.

Fig. 12, chytrid with radiating hairs on sporangium, found on *Cladophora*, $\times 375$; Fig. 13, *Rhizophidium gibbosum*, two undischarged sporangia on *Navicula*; also the discharged sporangium of an undetermined chytrid, $\times 375$; Fig. 14, *Aphanomycopsis bacillariacearum*, two discharged sporangia on *Pinnularia*, $\times 375$; Figs. 15-22, *Rhizophidium* sp., Fig. 15, infected fragment of a filament bearing a group of mature resting spores with companion cells, and copulating thalli, Fig. 16, two young thalli, Fig. 17, copulating thalli, showing fertilization tube, Fig. 18, discharging sporangium, Fig. 19, group of thalli on surface of host showing elongate (fertilization ?) tubes, Fig. 20, typical group of copulating thalli on surface of host cell, Fig. 21, mature resting spore with irregular, brown incrustation on the wall, and an adherent male cell torn from its rhizoidal system, Fig. 22, copulating thalli on surface of host cell showing fertilization tube with unusual clarity, all $\times 692$; Fig. 23. *Pythiogeton transversum*, group of sporangia, one of which has recently discharged its contents. The latter is shown being cleaved into zoöspores. This mass was about five times farther removed from the discharge tube than here depicted, $\times 260$; Fig. 24. *P. transversum*, mass of zoöspores nearly mature, $\times 260$.

TWO APPLE BLACK ROT FUNGI IN THE UNITED STATES

NEIL E. STEVENS

(WITH 1 TEXT FIGURE)

In their studies of the black rot of apple and its causal organism, various investigators have discussed without reaching any real agreement, one or both of two apparently somewhat unrelated points; whether the fungus designated by Peck as *Sphaeropsis malorum* is identical with that to which Berkeley gave the same name, and whether the black rot of the eastern United States is also present in the apple-growing States of the Northwest. In the course of work on this group of fungi, it has become apparent that the two questions are interdependent—at least to the extent that confusion on the first point has apparently contributed to lack of agreement on the second. It is, therefore, proposed to discuss the available evidence, which has led to the present conclusion that Berkeley's fungus and the "*Sphaeropsis*" most frequently found on apple and pear in Oregon are identical but that this species is not the one studied and described by Peck and which is common in the Eastern United States on apple and many other hosts. Since the writer's opinion is at variance with that held by several experienced investigators, the evidence will be presented in some detail.

THE TYPE SPECIMENS

BERKELEY'S TYPE. In 1836 Berkeley (1) discovered a fungus fruiting on a decayed apple and described it under the name of *Sphaeria malorum*. In 1860 (2) he changed the name to *Sphaeropsis malorum*. The type specimen is now in the Berkeley Herbarium at Kew, England, and from this, through the courtesy of the Director, we have been furnished several excellent slides.

PECK'S TYPE. Attention has several times been called to the fact that Peck at first considered the fungus which he found causing a black rot of apples in New York State as identical with

Berkeley's, and in his publications, 1878 (5) and 1881 (6), used the name *Sphaeropsis malorum* Berk. In 1884, Saccardo (8) transferred Berkeley's fungus to the genus *Phoma* as it was described as having hyaline spores, and made the combination *Phoma malorum* (Berk.) Sacc. Since Peck's fungus had brown spores Saccardo considered it not the same as Berkeley's and used for it the name *Sphaeropsis malorum* Peck, which designation was apparently adopted by Peck himself as several of his specimens are so labeled.

This circumstance aids in determining which of Peck's specimens of *S. malorum* is to be considered his type. Peck rarely indicated the year in which specimens were collected. Since, however, only one bears the label *S. malorum* Berk., this is probably the oldest, and must be considered his type. Dr. House, the present Curator of the New York State Herbarium, states that the probability of this being the oldest of Peck's specimens is further confirmed by the fact that the label is on thin blue paper of the kind earliest used by Peck. This specimen consists of a small mummified apple, covered with pycnidia.

STROMATIC CHARACTERS

The two fungi are certainly very similar in stromatic characters and in the structure of the pycnidia, which for Peck's fungus have been well described and illustrated by Hesler (4).

Continued study of this group has, however, convinced the writer that stromatic characters are so variable in these fungi as to be worthless for diagnostic purposes. The size of the stroma and the number of and the complexity of the spore chambers varies with the substratum. Subcultures from a single spore culture grown on twigs with such different bark structures as raspberry and currant look quite different in size and general appearance and both differ from those grown in pure culture on corn meal. The pycnidia on the smooth, thin bark of the raspberry are small and unilocular, while those on currant are thicker walled and multilocular, and those on corn meal have thick loosely woven walls. The amount of hirsuteness is markedly influenced by humidity—pycnidia produced on twigs in culture flasks which give a variable

humidity show a regular gradation being much more hairy where humidity is high and smooth surfaced where the humidity is low.

Attention has, of course, been frequently called to the extreme variability of the stroma in this group of fungi. More than fifty years ago Ellis (3) discussed the same point with reference to what he then called *Sphaeria quercuum* Schw. Ellis pointed out that the variation in the size and structure of the stromata is not accompanied by a corresponding variation in the "fruit," and he refuses to consider stromatic variation alone as a specific difference, and uses the following figure:

"With just as much reason might a specific distinction be made between the cluster of culms sprung from a single grain of wheat planted in a good soil and the single culm from another grain growing in a poorer soil."

SPORE CHARACTERS

The only constant difference between these two fungi which the writer has thus far discovered is in the spore characters. The spores in Berkeley's fungus are rather regular in form measuring $9-13 \times 22-33 \mu$, mostly $9.5-10 \times 23-29 \mu$. Most of them are hyaline, nonseptate, with a relatively thick wall which appears glassy under the microscope. This wall is very characteristic and is similar to that seen in hyaline pycnospores of the tropical and southern fungus known under a variety of names, including *Diplodia natalensis* and *D. cacaoicola*.

Slide No. 3215 from Berkeley's type contains in addition to numerous hyaline, nonseptate spores, a few light tan nonseptate spores measuring $15 \times 27-30 \mu$, and one light tan one septate spore— $12 \times 30 \mu$. Slide No. 3216 also contains one tan septate spore— $12 \times 24 \mu$.

The spores of Peck's fungus, however, differ from those of Berkeley's being uniformly tan to brown in color and many of them being rather irregular in shape. Some of these spores are septate but there is no constant difference in color between septate and nonseptate spores. The spores of Peck's type specimen measure $12-18 \times 24-30 \mu$, mostly $12-13 \times 25-27 \mu$.

The chief difference between the two fungi is in the shape, size, and particularly the color or rather the time of coloring of the

pycnospores. Those of Berkeley's fungus are somewhat more regular in shape, longer in proportion to their width and judging from the number of hyaline spores, remain hyaline for a considerable length of time before becoming brown and septate. The pycnospores of the fungus described by Peck, on the other hand, almost invariably become colored while still in the pycnidium, as illustrated in Peck's figure.

Whether such differences can safely be regarded as specific depends in a large part on whether they are constant. On this point, the behavior of what appear to be the same fungi in cultures made from recent collections should throw some light. Berkeley's fungus is represented among others by our culture No. 1286 on cut apple branch from Torquay, England. These cultures show the characteristics to be expected from the appearance of the slides made from the host, that is, the spores remain hyaline for a relatively long period and in general become colored after they are extruded from the pycnidium. Peck's fungus is represented by cultures from numerous hosts, including apple, in Eastern United States. In all of these the pycnospores are regularly colored before extrusion. In view of the apparent constancy of their spore characters the writer is inclined to consider these two fungi at least specifically distinct. It may be noted, without attempting to review the synonymy at this time, that Petrak and Sydow (7) find this difference in time of coloring so constant that they consider it the most reliable character for distinguishing the separate genera in which they place the two fungi here under consideration.

HOST RELATIONS

It is the unanimous opinion of those writers who have studied the apple black rot fungus in the field that it grows readily as a saprophyte on a very large number of host species. While parasitism is apparently rather limited even on the apple, the fungus is found more commonly on plant parts which have been cut or broken by the wind or have suddenly been killed by lightning, fire, or disease. Where fungi of this type are common they generally appear on cut trees or branches, often to the exclusion of other fungi. Incidentally it is obvious that such favorable

substrata must have become much more abundant in this country since the advent of the white man.

The following list of host genera on which this species has been found will serve as a concrete example of its omnivorous nature.

<i>Acer</i>	<i>Elaeagnus</i>	<i>Platanus</i>
<i>Aesculus</i>	<i>Euonymus</i>	<i>Populus</i>
<i>Ailanthus</i>	<i>Ficus</i>	<i>Prunus</i>
<i>Amorpha</i>	<i>Fraxinus</i>	<i>Psedera</i>
<i>Amygdalus</i>	<i>Gleditsia</i>	<i>Pueraria</i>
<i>Aristolochia</i>	<i>Hibiscus</i>	<i>Pyrus</i>
<i>Artemisia</i>	<i>Hicoria</i>	<i>Quercus</i>
<i>Benzoin</i>	<i>Ilex</i>	<i>Rhus</i>
<i>Carissa</i>	<i>Juglans</i>	<i>Ribes</i>
<i>Cassandra</i>	<i>Juniperus</i>	<i>Ricinus</i>
<i>Castanea</i>	<i>Larix</i>	<i>Robinia</i>
<i>Ceanothus</i>	<i>Lonicera</i>	<i>Rosa</i>
<i>Celastrus</i>	<i>Maclura</i>	<i>Rubus</i>
<i>Celtis</i>	<i>Magnolia</i>	<i>Salix</i>
<i>Cercis</i>	<i>Malus</i>	<i>Sambucus</i>
<i>Citrus</i>	<i>Melia</i>	<i>Sassafras</i>
<i>Cladonia</i>	<i>Morus</i>	<i>Smilax</i>
<i>Clematis</i>	<i>Negundo</i>	<i>Taxus</i>
<i>Convulvulus</i>	<i>Onagra</i>	<i>Tilia</i>
<i>Cornus</i>	<i>Opulaster</i>	<i>Ulmus</i>
<i>Corylus</i>	<i>Opuntia</i>	<i>Viburnum</i>
<i>Crataegus</i>	<i>Ostrya</i>	<i>Vinca</i>
<i>Cydonia</i>	<i>Phleum</i>	<i>Vitis</i>
<i>Diospyros</i>	<i>Pinus</i>	<i>Wisteria</i>
		<i>Zea</i>

DISTRIBUTION OF THESE TWO FUNGI IN THE UNITED STATES

In this paper the common apple black rot fungus described by Peck is designated as *Physalospora obtusa* (Schw.) Cooke, and Berkeley's fungus as *Diplodia mutila* Fries. The reason for this choice of names will be presented in detail in a later section. For the purpose of discussing the distribution of these fungi, it is of no importance whether one considers them as varieties of a single species, as separate species of a genus, or as belonging to separate genera. In any case, the available information regarding their distribution indicates that the apple black rot fungus is very common in the eastern part of the United States and has not yet been found in the northwestern section. It is, however, found in southern Europe. On the other hand, the apple fungus of the Pacific

Coast is very rare in the eastern United States but relatively common in western Europe. The map, figure 1, gives the known distribution of these two fungi in the United States as represented by material now in the Mycological Collections of the Bureau of Plant Industry, including a large number of specimens collected during the last twenty years by Dr. C. L. Shear and the writer. Dots mark those localities in which pycnidial material of *P. obtusa* (Schw.) Cooke has been found, and circles mark the localities in

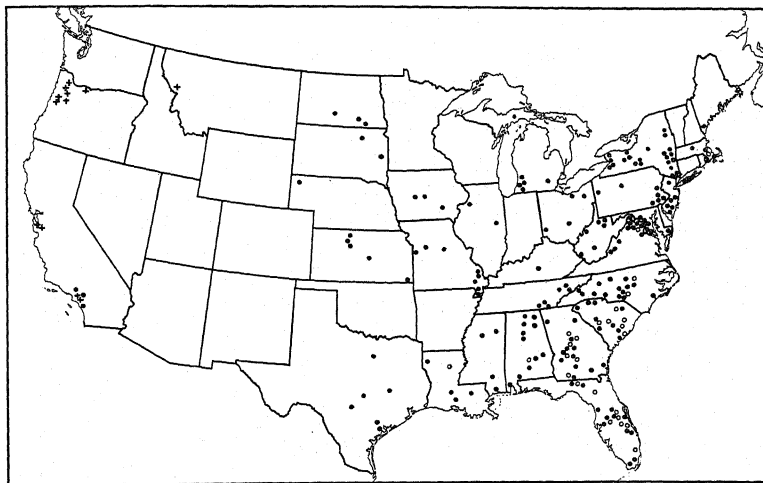


FIG. 1. Distribution in the United States of the two fungi discussed in this paper as indicated by specimens in the Mycological Collections of the Bureau of Plant Industry.

- Circles = Ascospore material of *Physalospora obtusa* (Schw.) Cooke.
 Dots = Pycnospor material of *P. obtusa*.
 + = *Diplodia mutila* Fries.

which ascospore material of this species has been found. There are thus indicated here only ascospore specimens from which cultures have been made and typical pycnidia produced in the cultures.

These two symbols thus show the known distribution of this species in the continental United States, namely, a few collections in southwestern California, and a wide distribution east of the Rocky Mountains. It is much more abundant in the well wooded states east of the Mississippi Valley, the predominance in this region being much greater than the map indicates. It is impos-

sible to show on so small a scale all the collections in States where much work has been done, as for example, in the vicinity of Albany, New York; Newfield, New Jersey; Washington, D. C., etc.

Mature ascospore material of *P. obtusa* is much more abundant in the southeastern than in the northeastern States, in this region the number of specimens which might be obtained is practically limited only by the time available for collecting.

So far as our collections indicate *Diplodia mutila* is confined in the United States to the far west. The most easterly point so far reported is Missoula, Montana, where two specimens were gathered by Weir. Four collections are known from California. These are from two localities near the Coast in regions of intensive cultivation. The fungus has been collected a number of times in western Oregon. As already noted this fungus is also fairly common in western Europe. Students of plant distribution have long recognized the close similarity of western Europe and the northwestern United States.

PHYSALOSPORA OBTUSA

Recent statements regarding the names of the apple black rot fungus have usually been rather guarded. Hesler (4) in announcing his discovery of the perfect stage of the fungus tentatively referred it to *Physalospora Cydoniae*, and added (p. 100), "The question of the specific name is still unsettled, for it is not improbable, as stated above, that the organism has been previously described under some other specific name."

The suggestion of Shear, Stevens and Wilcox (9) (p. 100) is as follows, "The writers are now inclined to believe that the safest citation for the pycnidial stage of the organism in question is *Sphaeropsis malorum* (Peck), and for the ascogenous stage, *Physalospora malorum* (Peck)." These writers apparently had in mind conserving the name *S. malorum* which is strongly entrenched in American usage. In view, however, of the fact that the specific name "malorum" had previously been applied to another fungus by Berkeley it is perhaps wiser to abandon it in favor of an older name.

The oldest names applied to this fungus which the writer has thus far found are those given by Schweinitz. Careful study of

his type material both in the Schweinitz Herbarium at Philadelphia and the Michener Herbarium now in the United States Department of Agriculture shows at least ten with Schweinitzian names to be synonyms of *S. malorum* of Peck. Only one of these specimens, namely, *Sphaeria obtusa*, shows ascospores.

The presence of ascospores in the portion of this type specimen in Ravenel's Herbarium in the British Museum was noted by Cooke who made the combination, *Physalospora obtusa*.

P. obtusa (Schw.) Cooke is represented in our collection by specimens from the Michener Herbarium, and by a slide from a specimen in the original packet of Schweinitz in the Philadelphia Academy of Natural Sciences. The specimens in both the Michener and Schweinitz Herbaria are in excellent condition and both show a number of mature pycnosporos $9-13 \times 19-28 \mu$, mostly $12 \times 24-28 \mu$ in size, uniformly tan in color, and many of them septate.

In stromatic and pycnosporos characters this material is almost an exact duplicate of Peck's type of *Sphaeropsis malorum*. One of the specimens also contains stromata with numerous mature, hyaline ascospores $10-12 \times 26-32 \mu$. While it is, of course, impossible to prove the connection of the two spore forms they are closely associated, and the relation of similar spore forms has been frequently demonstrated in cultures, so there is no reason to doubt that the material Cooke examined in Berkeley's Herbarium and transferred to the genus *Physalospora* was of this species. Schweinitz' name *S. obtusa* was published in 1832 and Cooke's *P. obtusa* in 1892. There seems then to be good reason to designate this fungus as *P. obtusa* (Schw.) Cooke.

PHYSALOSPORA OBTUSA (Schw.) Cooke, Grevillea 20: 86. 1892.

A complete synonymy of a fungus so widely distributed, on such a variety of hosts, and so easily collected and preserved will not soon be prepared. The present list must be regarded as merely preliminary. Synonyms based on examination of type or authentic material of perithecial as well as pycnidial stages.

Sphaeria obtusa Schw. Trans. Am. Phil. Soc. II. 4: 220. 1832.

Melanops quercum (Schw.) Rehm forma *Vitis* Sacc. Sec. Shear, Science 31: 748. 1910.

Physalospora Cydoniae Arnaud, Sec. Hesler, Bull. Cornell Univ. Agri. Exp. Sta. 379: 101. 1916.

Physalospora malorum (Peck) Shear, Mycologia 17: 100. 1925.

Synonyms based on examination of type or authentic material of pycnidial stage only.

Sphaeria Gleditseae Schw. Trans. Am. Phil. Soc. II. 4: 40. 1832.

Sphaeria junipericola Schw. Trans. Am. Phil. Soc. II. 4: 205. 1832.

Sphaeria subfasciculata Schw. Trans. Am. Phil. Soc. II. 4: 214. 1832.

Sphaeria pericarpii Schw. Trans. Am. Phil. Soc. II. 4: 215. 1832.

Sphaeria ampelos Schw. Trans. Am. Phil. Soc. II. 4: 217. 1832.

Sphaeria albo-farcta Schw. Trans. Am. Phil. Soc. II. 4: 218. 1832.

Sphaeria rhuina Schw. Trans. Am. Phil. Soc. II. 4: 218. 1832.

Sphaeria Lonicerae Sow. Trans. Am. Phil. Soc. II. 4: 219. 1832.

Sphaeria pyrina Fries, Sec. Schw. Trans. Am. Phil. Soc. II. 4: 219. 1832.

Sphaeria druparum Schw. Trans. Am. Phil. Soc. II. 4: 219. 1832.

Sphaeria saepincola Fries, Sec. Schw. Trans. Am. Phil. Soc. II. 4: 220. 1832.

Sphaeria meloplaca Schw. Trans. Am. Phil. Soc. II. 4: 223. 1832.

Diplodia seriata De-Not, Micr. Ital. Dec. IV, n. 6. 1837.

Sphaeropsis Platani Peck, Ann. Rep. N. Y. State Mus. 25: 85. 1873.

Sphaeropsis fusiger Berk. & Curt. Grevillea 2: 181. 1874.

Sphaeropsis tephrospora Berk. & Curt. Grevillea 2: 180. 1874.

Sphaeropsis pennsylvanica Berk. & Curt. Grevillea 2: 180. 1874.

Sphaeropsis Sumachi Cooke & Ellis, Grevillea 5: 31. 1876.

Sphaeropsis rubicola Cooke & Ellis, Grevillea 5: 55, pl. 80. 1876.

- Sphaeropsis fibriseda* Cooke & Ellis, Grevillea 5: 89. 1877.
Sphaeropsis Punctum Cooke & Ellis, Grevillea 6: 2, pl. 96. 1877.
Sphaeropsis rosarum Cooke & Ellis, Grevillea 6: 2. 1877.
Sphaeropsis rubicola Cooke & Ellis, Grevillea 6: 2-3, pl. 95. 1877.
Sphaeropsis clethraecola Cooke & Ellis, Grevillea 6: 84. 1878.
Sphaeropsis Cydoniae Cooke & Ellis, Grevillea 6: 84. 1878.
Diplodia decorticata Cooke & Ellis, Grevillea 6: 85. 1878.
Sphaeropsis Macluræ Cooke, Grevillea 6: 134. 1878.
Sphaeropsis opaca Cooke & Ellis, Grevillea 7: 5. 1878.
Melogramma fuliginosa (Moug. & Nest.) Ellis, Proc. Acad. Phila. 1879: 70. 1879.
Sphaeropsis abundans Peck, Ann. Rep. N. Y. State Mus. 33: 24. 1880.
Sphaeropsis cerasina Peck, Ann. Rep. State Mus. 33: 24. 1880.
Sphaeropsis phomatella Peck, Ann. Rep. N. Y. State Mus. 33: 24. 1880.
Sphaeropsis seriatus Peck, Ann. Rep. N. Y. State Mus. 33: 24. 1880.
Sphaeropsis malorum Peck, Ann. Rep. N. Y. State Mus. 34: 36. 1881.
Diplodia pinea Kx. var. *corticola* Peck, Ann. Rep. N. Y. State Mus. 38: 98. 1885.
Sphaeropsis tiliacea Peck, Ann. Rep. N. Y. State Mus. 39: 45. 1886.
Diplodia caryigena Ellis & Ev. Proc. Acad. Phila. 1894: 363. 1895.
Sphaeropsis Physocarpi Ellis & Ev. Proc. Acad. Phila. 1894: 361-362. 1895.
Sphaeropsis Oenotheræ Ellis & Ev. Field Columb. Mus. 9: 114. 1896.
Sphaeropsis Robiniae Ellis & Barth. Erythea 4: 81. 1896.
Sphaeropsis triacanthi Ellis & Barth. Erythea 4: 81. 1896.
Sphaeropsis Ailanthi Ellis & Barth. Erythea 5: 48. 1897.
Sphaeropsis Phlei Ellis & Ev. Am. Nat. 31: 429. 1897.
Sphaeropsis Populi Ellis & Barth. Erythea 5: 49. 1897.
Sphaeropsis ulmea Ellis & Barth. Erythea 5: 49. 1897.
Sphaeropsis fertilis Peck, Bull. Torrey Club 25: 327. 1898.

Sphaeropsis Juglandis Ellis & Barth. Trans. Kans. Acad. Sci. 16: 166. 1899.

Sphaeropsis Persicae Ellis & Barth. Jour. Myc. 8: 175. 1902.

Sphaeropsis Magnoliae Ellis & Dearn. Fungi Columb. no. 2087. 1905.

Sphaeropsis Ceanothi Dearn. & House, Bull. N. Y. State Mus. 188: 40. 1916.

Sphaeropsis parallela Dearn. & House, Bull. N. Y. State Mus. 188: 40. 1916.

Sphaeropsis Viburni-dentati Dearn. & House, Bull. N. Y. State Mus. 188: 41. 1916.

Diplodia Convolvuli Dearn. & House, Bull. N. Y. State Mus. 197: 28. 1917.

Sphaeropsis Aristolochiae Dearn. & House, Bull. N. Y. State Mus. 197: 43. 1917.

Sphaeropsis punctata Dearn. & House, Bull. N. Y. State Mus. 197: 36. 1917.

Sphaeropsis Negundinis Tehon & Daniels, Mycologia 17: 242-243. 1925.

Sphaeropsis Clematidis Dearn. & House (*Macroplodia Clematidis* Dearn. & House), N. Y. State Mus. Bull. 266: 85. 1925.

Unpublished Names

Sphaeria pomarum Berk. & Curt. (In herb.)

Sphaeropsis pomorum Berk. & Curt. (In herb.)

Sphaeropsis pulvinacea Berk. & Curt. (In herb.)

Sphaeropsis semitecta Berk. & Curt. (In herb.)

Sphaeropsis subcuticularis Dearn. & House. (In herb.)

DIPLODIA MUTILA

In suggesting *Diplodia mutila* Fries as the name for the fungus described by Berkeley as *Sphaeropsis malorum*, it is not intended to raise the question as to whether both *Sphaeropsis* and *Diplodia* can be retained as valid genera. The intention here is merely to indicate the earliest known name for the fungus under discussion. It should be remembered that only the pycnidial stage of this fungus is known and until the perithecial stage is demonstrated by actual connection in pure culture further discussion as to its relationship to *P. obtusa* is futile.

Sphaeria mutila was described by Fries in 1823. Two numbers of this species distributed by Fries in his Scler. Suec. 164 and 385, show no spores in the set now in the Mycological Collections of the Bureau of Plant Industry.

In 1834, Montagne submitted to Fries a specimen of a fungus from *Populus* sp. which Fries determined as identical with *Sphaeria mutila*, and on the basis of which he established a new genus *Diplodia*, the first description of which was published by Montagne in 1834 as follows:

No. 27. *S. mutila* Fries, l. c. p. 424. PLATE 13, FIG. 7. Exs. Desmaz. Crypt. n. 619.—Nobis, n. 498.

Cette espèce devenue le type du nouveau genre *Diplodia*, ainsi caractérisé par M. Fries: Asci elliptico-oblongi, didymi, sporidiis binis referti.—Sur le tronc d'un Peuplier mort, dans le parc de M. Lamotte, à Sedan.

Examination of several good slides of Montagne's No. 498, taken directly from an autograph specimen in the herbarium at Strasburg, shows only pycnidia with the structure typical of this group and with spores $10-16 \times 20-27$, mostly $10-12 \times 25-27 \mu$. Both hyaline one-celled and tan one-septate spores are present, the hyaline spores having the characteristic glassy walls mentioned in discussing the type of Berkeley's specimen.

A careful comparison of these two specimens leads to the conclusion that the species are identical and that Berkeley's name should give way to the much older—*D. mutila*. The only possible basis for separation is that of host, which was long ago discredited by those who have studied this fungus in the field.

DIPLODIA MUTILA (Fries) Mont. Ann. Sci. Nat. II. 1: 302. 1834.

Sphaeria mutila Fries, Syst. Myc. 2: 424-425. 1823.

Sphaeria Amorphae Wallr. Flora Crypt. Ger. 2: 781. 1833.

Sphaeria malorum Berk. Eng. Fl. 5: 257, Part II. 1836.

Diplodia Aesculi Lév. Ann. Sci. Nat. III. 5: 290. 1846.

Diplodia melaena Lév. Ann. Sci. Nat. III. 5: 292. 1846.

Sphaeropsis sociata Lév. Ann. Sci. Nat. III. 5: 295. 1846.

Sphaeropsis cylindrospora Desm. Ann. Sci. Nat. III. 11: 277. 1849.

Sphaeropsis malorum Berk. Outlines Brit. Fung. 316. 1860.
Diplodia quercina West. Bull. Acad. Belg. II. 2: 560, No. 7.
1857.

Diplodia Quercus Fuckel, Symb. Myc. 170. 1869.

Diplodia samararum Sacc. Mycoth. Ven. Cent. 14, n. 1396.
1879.

Diplodia rhuina Cooke & Hark. Grevillea 9: 6, Sept. 1880.

Diplodia cynanchina Petrak, Ann. Myc. 20: 13. 1922.

Unpublished Names

Diplodia Acubae West. (In herb.)

Diplodia Marsdeniae Thüm. (In herb.)

Sphaeropsis Diospyri Berk. & Br. In herb. not the *S. Diospyri*
of Dearn. & Barth.

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NOTES AND BRIEF ARTICLES

A general index to the seven volumes of the Mycological Writings of the late Curtis G. Lloyd of Cincinnati, Ohio, has been prepared and published by the Lloyd Library and Museum. Copies may be secured by those possessing sets of Mr. Lloyd's writings upon application to the Librarian at Cincinnati or to John A. Stevenson, Custodian, C. G. Lloyd Mycological Collections, Smithsonian Institution, Washington, D. C.

ENDOTHIA PARASITICA IN WASHINGTON

Chestnut blight or better perhaps "Chestnut Canker" which has interested plant pathologists in eastern United States for over a quarter of a century was discovered in Seattle on American Chestnut (*Castanea dentata*) during the summer of 1932. Specimens were sent to Dr. F. D. Heald of the State College at Pullman, Washington, and also to Dr. C. L. Shear of the Bureau of Plant Industry, Washington, D. C., both of whom confirmed the determination.

Scouting and inquiry in the immediate vicinity of Seattle revealed one infected tree at Laurelhurst, a suburb, and four on the University Campus all about the same age, five to eight years old. It was further learned that all these trees were grown in the same nursery from seed sent from New York State from what was believed to be a non-infected region. An examination of the infected trees showed that in all cases the original infections were at or near the ground and only one case could be found where there appeared to be a secondary infection on an upper branch. Careful search has failed to find older Chestnut trees infected although some were growing within twenty or thirty feet of the infected ones. During the past summer scouting was carried on in the vicinity of Seattle but no additional infections were discovered. A circular letter was also addressed to many of the nurserymen in Western Washington but without obtaining any additional facts.

This is the first record of this disease in the State of Washington. A few infected trees, however, were reported at the Experimental Farm at Agassiz, B. C. about 1914, and at Gunter, Oregon, in 1929. In both these regions the disease has apparently been eradicated.

The information at hand seems to indicate that this outbreak of Chestnut blight at Seattle has come from imported infected seed. It is hard, however, to conceive of this organism taking five to eight years to kill Chestnut seedlings unless in the Pacific Northwest it behaves differently from what it does in eastern United States. There are some indications that this may be true.

JOHN W. HOTSON

UNIVERSITY OF WASHINGTON,
SEATTLE, WASHINGTON

MYCOLOGICAL SOCIETY OF AMERICA

SUMMER FORAY

At the invitation of the Director and Trustees of the Highlands Museum and Biological Laboratory, the first summer foray of the Mycological Society of America was held at Highlands, North Carolina. Situated at an altitude of nearly four thousand feet in the Blue Ridge of southwestern North Carolina, not far from the borders of Georgia and South Carolina, in a region of dense forests and abundant moisture, Highlands represents an ideal location for mycological collecting. A wide range of habitats is available within easy walking distance and short automobile trips afford an infinite variety of natural conditions, together with unexcelled mountain scenery.

The morning of August 17 was spent in a second growth white pine plantation near at hand. Agarics and clavarias were abundant. A gentle rain dampened the clothing but not the enthusiasm of the group and after lunch in town the sun came out, promising good weather for the trip up Black Rock Mountain in the afternoon. Later, the weather became threatening and there were occasional light showers, but good collecting was experienced on the way up and an impressive view of mountain scenery enjoyed from the summit. It started to rain in earnest before we started down, and everyone was thoroughly soaked on the trip back. However,

we reached shelter without serious harm and those who had been sufficiently foresighted changed to dry clothing. The evening was spent at the laboratory caring for collections and in informal discussion.

The following days were fortunately clear. On Friday morning a walk of five miles took us past the beautiful Highlands Falls and through the primeval forest of the Ravenel tract, a nearly pure stand of giant hemlocks, interspersed with enormous cherries



From left to right: J. H. Miller, A. F. Grassmyer (kneeling), L. R. Hesler, W. W. Diehl, L. O. Overholts, Nell Henry, C. L. Shear, Caroline A. Lander, G. W. Martin, Alma Holland, Edith K. Cash, Vera K. Charles, J. P. Porter, T. G. Harbison.

and with an undergrowth of dense laurel thicket, the floor being an accumulation of humus such as few of us had seen. As might be expected, collecting was rich in the extreme, and most of the afternoon was spent in studying and drying the collections of the morning, with a few informal trips by those who felt they could spare the time. In the evening the group was entertained by Professor Coker at his summer home, in delightfully informal fashion.

Saturday morning a short business session was held, with President Shear in the chair. The following resolution was adopted:

The members of the Mycological Society of America attending the Highlands Foray wish to extend to the Director and Trustees of the Highlands Museum and Biological Laboratory their appreciation of the privileges accorded them, and to the members of the local committee their thanks for arranging for accommodations and planning the excursions in such a way as to insure a successful and enjoyable meeting.

The desirability of publishing records of collections at the foray was discussed. It was the sense of the meeting that each individual submit as complete a list as possible of the species collected to Dr. Hesler, with the thought that these be incorporated in a general list of the fungi of the region to be issued by the Highlands Museum and Biological Laboratory. It was further voted that each individual note new or noteworthy species occurring on his list and that Dr. Hesler collate and edit a list of such species for publication in *Mycologia* at an early date.

Following adjournment, the rest of the morning was spent in caring for collections and in short informal excursions. In the afternoon most of the party went by automobile to the upper falls of the Whitewater River, near the South Carolina border, in a deep, densely forested interior valley entirely surrounded by high mountains. Time did not permit extensive collecting but an unusual opportunity was afforded to visit a section of the mountains rarely seen by outsiders.

While the attendance was small, those who were there were unanimous in feeling that the meeting was well worth while, both in the opportunities afforded for collecting in a region of great botanical and mycological interest and for the chance afforded to make or renew personal acquaintance under the most favorable circumstances. Incidentally, thanks to the arrangements made by the local committee, consisting of Dr. Coker, Dr. Reinke and Dr. Hesler, excellent accommodations were provided at very moderate cost.

It is to be hoped that mycologists in increasing numbers will avail themselves of the facilities afforded by the laboratory to study fungi in this fascinating region.

GEORGE W. MARTIN,
VICE-PRESIDENT

INDEX TO VOLUME XXV

INDEX TO AUTHORS AND TITLES

- Aronescu, Alice. Further studies in *Neurospora sitophila* 43
 Arthur, J. C. Faull's monograph of the genus *Milesia* 65
 — & Cummins, G. B. Rusts of the northwest Himalayas 397
 Ayers, T. T. Growth of *Dispira cornuta* in artificial culture 333
 Bechtel, A. R. The lifting power of a mushroom 150
 Bose, S. R. Abnormal spores of some *Ganoderma* 431
 Cash, E. K. & Davidson, R. W. Species of *Sclerotinia* from Grand Mesa National Forest, Colorado 266
 Coker, W. C., Reinke, E. E. & Hesler, L. R. The mycological foray 330
 Cummins, G. B. & Arthur, J. C. Rusts of the northwest Himalayas 397
 Davidson, R. W. & Cash, E. K. Species of *Sclerotinia* from Grand Mesa National Forest, Colorado 266
 Dodge, B. O. The perithecium and ascus of *Penicillium* 90
 Ezekiel, W. N. & Taubenhaus, J. J. A new hollyhock rust 509
 Fitzpatrick, H. M. The Mycological Society of America 66, 152
 Garrett, A. O. *Urocystis Heucherae* sp. nov. 151
 Gill, D. L. *Plasmopara Halstedii* on *Cineraria* 446
 Greene, H. C. Variation in single spore cultures of *Aspergillus Fischeri* 117
 Hahn, G. G. An undescribed *Phomopsis* from Douglas Fir on the Pacific Coast 369
 Hedgcock, G. G. & Hunt, N. R. Notes on some species of *Coleosporium* —III 392
 Hedrick, Joyce. New genera and species of lichens from the herbarium of Bruce Fink I 303
 Hesler, L. R., Coker, W. C. & Reinke, E. E. The mycological foray 330
 Hotson, J. W. *Endothia parasitica* in Washington 549
 Hunt, N. R. & Hedgcock, G. G. Notes on some species of *Coleosporium* —III 392
 Jenkins, A. E. Additional studies of species of *Elsinoe* and *Sphaceloma* 213
 Kern, F. D. The microcyclic species of *Puccinia* on *Solanum* 435
 — & Thurston, H. W. Distribution of West Indian Rusts 58
 —, Thurston, H. W. & Whetzel, H. H. Annotated index of the rusts of Colombia 448
 Linder, D. H. *Tremella gangliiformis*, a new and unique tremellaceous fungus, 105; North American Hyphomycetes—I. Two new Helicosporeae and the new genera *Haplochalara* and *Paspalomyces* 342
 Lohman, Marion. *Septonema toruloideum* a stage of *Mytilidion scoleosporum* 34
 Mains, E. B. Studies concerning heteroecious rusts 407
 Martin, G. W. Mycological Society of America 550
 Miller, J. H. Some new species of *Hypoxylon* 321
 Miller, L. W. The genera of Hydnaceae 286; The Hydnaceae of Iowa —I. The genera *Grandinia* and *Oxydontia* 356
 Morse, E. E. A study of the genus *Podaxis* 1
 Muskatblit, E. Observations on *Epidermophyton rubrum* or *Trichophyton purpureum* 109
 Overholts, L. O. Mycological notes for 1930–32 418
 Parker, C. S. A taxonomic study of the genus *Hypholoma* in North America 160
 Reinke, E. E., Hesler, L. R. & Coker, W. C. The mycological foray 330

- Seaver, F. J. Photographs and descriptions of cup-fungi—XVIII. Rare species of *Godronia* 55; —XIX. The cabbage-head fungus 157; Translation of Tulasne's *Carpologia* 151
- & Velazquez, Josefa. *Dermea* and *Pezicula* 139
- Shear, C. L. Life histories of *Tryblidiella* species 274
- Sherbakoff, C. D. A new fungus parasitic on nematodes 258
- Snell, W. H. Notes on boletes—II 221; Reviews 233
- Sparrow, F. K. Inoperculate chytridiaceous organisms collected in the vicinity of Ithaca, N. Y., with notes on other aquatic fungi 513
- Stevens, N. E. Life history and synonymy of *Physalospora glandicola* 504; Two apple black rot fungi in the United States 536
- Taubenhaus, J. J. & Ezekiel, W. N. A new hollyhock rust 509
- Tehon, L. R. Notes on the parasitic fungi of Illinois 237
- Thurston, H. W. The standing of two species of *Uromyces* on *Panicum* 442
- & Kern, F. D. Distribution of West Indian rusts 58
- , Whetzel, H. H. & Kern, F. D. Annotated index of the rusts of Colombia 448
- Truscott, J. H. L. Observations on *Lagena radiculicola* 263
- Velazquez, Josefa & Seaver, F. J. *Dermea* and *Pezicula* 139
- Weston, W. H. Roland Thaxter 69; Dr. Thaxter's metal guard for microscope slides 317
- Whetzel, H. H., Kern, F. D. & Thurston, H. W. Annotated index of the rusts of Colombia 448
- Zeller, S. M. New or noteworthy agarics from Oregon 376
- Zundel, G. L. New and rare North and South American Ustilaginales 349

INDEX TO GENERA AND SPECIES

New names and the final members of new combinations are in **bold face type**. Mistakes in the spelling of scientific names encountered in text are corrected in the index.

- Abies balsamea* 421, 426, 429; *pectinata* 374
- Abutilon umbellatum* 471
- Acer* 145, 146, 426, 429, 540; *rubrum* 145, 421; *spicatum* 146
- Achlya* 515, 519, 524, 531
- Acia* 288, 294; *chrysocoma* 364; *setosa* 366, 367; *stenodon* 367, 368
- Acicella* 290
- Aconitum columbianum* 267; *lycotonum* 406; *moschatum* 404
- Acrotheca* 347
- Adenaria floribunda* 451, 496; *floribunda purpurata* 451, 496
- Adenoropium* 63
- Adhatoda vasica* 399
- Adoxa moschatellina* 402
- Aecidium* 61, 62, 399, 408, 450, 451, 455, 465; *absedens* 62; *Adenariae* 451, 496; *amaeque* 451; *aridum* 451, 452, 496; *Bocconiae* 452, 454; *bogotense* 452, 489, 498; *Bomareae* 452, 465; *Borreriae* 62, 452, 498; *Bourreriae* 62; *Cansici* 452, 497; *circumscriptum* 457; *Cissi* 452, 457; *Clibadii* 452, 457; *conspicuum* 408; *Cordia* 62; *crypticum* 398; *distinctum* 398; *distinguendum* 477; *domingense* 62; *Erigerontis* 452, 468; *Farameae* 62; *favaceum* 62; *flavescens* 398; *Girardiniae* 398; *guttatum* 457; *Gymnolomiae* 449, 452; *Hederae* 398; *Heliopsisidis* 452, 464; *hispaniolae* 62; *Ixora* 62; *Lantanae* 452, 499; *Liabi* 453, 499; *Lophanthi* 399; *Loranthi* 495; *Manettiae* 453, 499; *medelinense* 453; *montanum* 399; *orbiculare* 399; *paramense* 453, 498; *Pisoniae* 62; *simplicius* 62; *solanium* 439, 440, 467; *Spegazzinii* 453, 497; *Stachytarphetae* 453, 457; *Stewartii* 399; *Tournefortiae* 62; *Verbenae* 452; *Vernoniae-mollis*, 453, 455, 482; *Wedeliae* 453, 457
- Aeschynomene americana* 460, 496; *sensitiva* 460, 496
- Aesculus* 540
- Agaricus* 26, 161, 428; *arvensis* 150; *campestris* 7, 26; *capnoides* 194; *fascicularis* 194; *hydrophilus* 181; *incertus* 178; *inopus* 192; *lacrymabundus* 200; *lateritius* 192; *nitidipes* 209; *ornellus* 209; *perplexus*

- 192; Rodmani 26; saccharinophilus 209; sublateritius 192; velutinus 200
- Ageratum conyzoides 467, 496; conyzoides inaequipaleaceum 467, 496
- Agropyron caninum 409; repens 263; Smithii 409, 410; tenerum 409, 410
- Agrostis perennans 476, 477, 496
- Ailanthus 540
- Ainsliaea pteropoda 402
- Aira caespitosa 409; flexuosa 409
- Aleurodiscus 426; acerinus 426; amorphus 426; candidus 426; cerussatus 427; Farlowii 426; nivosus 427; Oakesii 427; penicillatus 427
- Allium tricoccum 426
- Alnus 142, 205, 387, 389, 421, 427; rubra 384
- Alpova 25, 27, 28
- Aleolaria 61, 453; Cordiae 453, 497
- Amanita muscaria 376
- Amaurodon 290
- Ambrosia artemisiaefolia 416; trifida 414
- Amelanchier 146, 270; alnifolia 143, 270
- Amorpha 540
- Amphicarpa 413; monoica 412, 413
- Amsonia 392
- Amygdalus 540; Persica 484, 496
- Anaethropia 63
- Andropogon 353, 412, 413; goyazensis 354; Ischaemum 402, 404, 406; macrothrix 354; Salzmannii 354; scoparius 412; virginicus 414
- Anemone 400; polyanthes 405; tetrasepala 404
- Angelica glauca 398
- Annona 62; Cherimolia 486, 496
- Anoda cristata 462, 496; hastata 462, 471, 496
- Antheophora hermaphrodita 466, 496
- Anthoceros 80
- Anthoxanthum odoratum 476, 496
- Anthurium 62, 485, 496
- Antidaphne 495; Fendleri 495, 496
- Anulosporium** 261, 262; **nematogenum** 262
- Aphanomyces 531; exoparasiticus 531; norvegicus 532; phycophilus 532
- Aphanomycopsis Bacillariacearum 530
- Aphelenchus 260
- Apium ternatum ranunculifolium 486, 496
- Apodachlya brachynema 532; piri-fera 532
- Aquilegia pubiflora 404; vulgaris 404
- Arabis 407
- Araiospora pulchra 81
- Arbutus 214; Unedo 213, 214
- Aristastoma** 248; **concentrica** 249
- Aristolochia 540
- Armillaria 377; granulosa 377; **granulosoides** 377; haematites 185; robusta 377; **rugoso-reticulata** 378; subannulata 390
- Arrhenatherum elatius 409
- Artemisia 540; Sieversiana 402
- Arthonia 311; diffusa 310, 311; **diffusella** 310; lapidicola 311; **rupicola** 310; **Willeyi** 311
- Arthopyrenia **dimidiata** 306; **distans** 307
- Arthrobotrys 261; oligospora 261
- Artocarpus 62; communis 485, 496
- Aschersonia 71, 73
- Asclepias curassavica 489, 496
- Ascochyta **plantaginella** 247
- Asparagus officinalis 251, 253
- Aspergillus 83, 90, 92, 94, 95, 100, 102; clavatus 81; Fischeri 117, 119, 120, 122-128, 130, 131, 136; fumigatus 120; fuscus 118; ochraceus 118
- Asphodelus tenuifolius 402
- Aster 392-394; asperulus 402; multiflorus 411, 412; paniculatus 395
- Asterodon 288-291; ferruginosum 291
- Asterostroma 291
- Asterostromella 358; granulosa 357
- Astilbe rivularis 406
- Aulographum Ledi 214, 215, 219
- Auriscalpium 289, 290, 296-298
- Avena fatua 409; sativa 476, 477, 496
- Axonopus marginatus 355; scoparius 472, 496
- Baccharis 62; anomala 485, 496; bogotensis 474, 496; cassinaefolia 470, 496; floribunda 465, 474, 496; nitida 462, 496; oronocensis 474, 496; polyantha 465, 496; rhexioides 463, 496
- Bambos 63
- Baptisia australis 413
- Bastardia viscosa 471, 496
- Batarrea 26; Guicciardiniana 7; phalloides 5
- Bauhinia 62
- Beauveria Bassiana 336; globulifera 336
- Beggiatoa mirabilis 81
- Belonia **americana** 309; fennica 310; herculana 310; russula 310; ter-rigena 310
- Beltramia 344, 345
- Benzoin 540
- Berberis 410, 411, 452; canadensis 409; chitria 399; Fendleri 409,

- 410; *Lycium* 399; *pseudumbellata* 403; *rigidifolia* 451, 496; *trifoliata* 409
Betula 142, 427, 429; *fontinalis* 57; *lutea* 57, 142
Bidens *bipinnata* 490; *cynapifolia* 490, 496; *frondosa* 447; *pilosa* 490, 496; *squarrosa* 490, 496
Bixa 62
Blastenia neomexicana 306
Blastocladia globosa 529; *Pringsheimii* 529
Blechnum 460; *blechnoides* 484, 496; *occidentale* 460, 496
Blechnum 478; *Brownei* 478, 496
Bletia 63
Bocconia frutescens 454, 464, 496
Bolbitis hydrophilus 181; **marginitipes** 378; *titubans* 378
Boletellus 230
Boletinus 229; *grisellus* 228, 229; *pictus* 229; *spectabilis* 229; *viscidus* 229
Boletus 222, 229, 232; *albus* 231, 232; *Ananas* 229-231; *badius* 225, 226; *Bellini* 232; *bicolor* 225; *Boudieri* 232; *brevipes* 224; *chrysenteron* 222; *Clintonianus* 221; *collinitus* 231; *communis* 222; *dichrous* 225; *elbensis* 221, 229; *elegans* 221; *erythropus* 227, 228; *felleus* 223; *ferrugineus* 226; *flavus* 221; *fusipes* 232; *glabellus* 224; *granulatus* 224, 231, 232; *iludens* 227; *isabellinus* 229-231; *luridus* 224, 227, 228; *luteus* 224; *miniato-olivaceus* 224; *miniatoportus* 227; *mutabilis* 231; *nebulosus* 223, 224; *placidus* 221, 232; *porphyrosporus* 221, 223; *purpureus* 228; *rhodoxanthus* 227, 228; *sordidus* 222, 223; *spadiceus* 225-227; *subalbellus* 229-231; *subtomentosus* 226, 227; *tridentinus* 229; *umbrosus* 222, 223; *vermiculosus* 224; *viscidus* 221, 229
Bomarea Caldasii 465, 496; *potacocensis* 465, 496
Bombax 465, 496
Borreria 62; *laevis* 472, 496; *latifolia* 472, 496; *tenella* 491, 496
Botryodiplodia gallae 241, 507
Botryorhiza 61
Botrytis 266, 268, 269
Bourreria 62
Bouteloua 62, 351, 352
Brachistum hebeophyllum 475, 496
Brachypodium mexicanum 481, 496
Bremia Lactucae 447
Bromus unioides 467, 496
Bubakia 461
Buchenavia 62
Buchnera 63
Buellia 312
Buettneria carthaginensis 470, 497
Bupleurum jucundum 402
Caldesiella 287-291; *ferruginosa* 291; *italica* 291
Calea glomerata 465, 497
Calliospora 61
Calodon 287, 289-291, 299, 300
Calostoma 26
Caltha palustris alba 402
Campanula 392; *canescens* 399
Campelia 62
Canna 465, 496; *coccinea* 465, 496
Cantharellus clavatus 379
Capriola Dactylon 468, 497
Capsicum 470, 497; *baccatum* 452, 466, 497
Cardiospermum 463, 497
Carex 267, 271, 272; *athrostachya* 272; *exsuccata* 271
Carissa 540
Carpinus 139; *caroliniana* 144
Carya 427, 429
Cassandra 540
Cassia Chamaecrista 416
Castanea 540; *dentata* 549
Cauloglossum 18, 19, 23, 26; *aegyptiacum* 14, 19, 23; *carcinomale* 13; *pistillare* 13
Ceanothus 203, 540
Cedrela serrata 400
Celastrus 540
Celtis 540
Cenangium Cerasi 141; *fuliginosum* 55, 56; *Prunastri* 141; *seriatum* 56, 57
Cenchrus echinatus 466, 497
Cephalanthus 62
Cephalophora 72
Cephalobus 260
Cerastium 419, 424; *vulgatum* 419, 424
Ceratostoma spurium 141
Cercis 540
Cercospora 284; *elongata* 422
Ceratomyces communis 222; *sordidus* 223
Cerotelium 61, 453; *desmium* 453, 487, 498; *Fici* 454, 498
Cerrena 286
Cestrum 490, 497; *parviflorum* 490, 497
Chaenoccephalus arboreus 478, 497
Chaerophyllum villosus 402
Chaetochloa geniculata 481, 497; *scandens* 465, 497
Chaetophora 517
Chainoderma 25, 26; *Drummondii* 25
Chalara 346
Chalaropsis 347

- Chamaefistula* 63
Chamaesaracha nana 439
Chamaesyce brasiliensis 495, 497, 498; *hirta* 495, 497
Chelone glabra 412, 413
Chiodecton ochroleucum 314; **sub-ochroleucum** 313
Chnoospora Butleri 399; *Sancti-johannis* 399
Chrysocelis 454; *Lupini* 454, 499
Chrysomyxa deformans 399
Chrysophyllum 62
Chrysopsis mariana 394
Chytridium 525; *acuminatum* 527; *anotropum* 516; *asymmetricum* 525; *breviceps* 527; *chaetophilum* 514, 526; *Confervae* 521; *inflatum* 527; *lateoperculatum* 528; *minus* 525; *Olla* 527; **papillatum** 514, 525; **perniciosum** 526-528; *pyriforme* 527; *rostellatum* 522; *sphaerocarpum* 527; *xylophilum* 528
Ciboria 270; *filipes* 270; *Johnsonii* 270
Cionium 18, 23; *senegalensis* 14, 18
Cionothrix 61, 456
Circaea alpina 402; *alpina himalaica* 402; *alpina intermedia* 402
Cissampelos 490, 497
Cissus 449, 457, 497, 502; *rhombifolia* 456, 497; *sicyoides* 457, 497, 502
Citrullus vulgaris 252
Citrus 540
Cladochytrium replicatum 524
Cladonia 540
Cladophora 514, 516, 518, 523, 524, 529, 532
Clathrus 17
Clavaria 17, 295
Clematis 540; *connata* 399; *grata* 399, 406; *montana* 399
Clibadium 457; *surinamense* 457, 497; *surinamense asperum* 457, 497
Climacodon 296, 297
Clitocybe dealbata 379
Clusia 62
Coccolobis 62
Coleosporium 61, 392, 394, 395, 454, 455; *Bocconiae* 452, 454, 496; *Campanulae* 399; *carneum* 392, 393, 395; *Clematidis* 399; *delicatum* 392, 395; *domingense* 454, 500; *Elephantopodis* 392-395, 454, 497; *Eupatorii* 455, 498; *Fischeri* 455; *Helianthi* 392, 395; **Heterothecae** 394, 396; *inconspicuum* 392, 395; *Inulae* 396; *Ipomoeae* 392, 395, 455, 499, 500; *Laciniariae* 394, 395; *Plumierae* 454; *ribicola* 392; *Solidaginis* 392, 395; *terebin-*
thinaceae 392; *Vernoniae* 453, 455, 482, 502
Colletotrichum aecicolum 254; **Dioscoreae** 255; **Smilacis** 254
Collomia 416; *linearis* 416
Comandra 413; *umbellata* 412, 413
Confertopeltis 251; **Asparagi** 251
Coniothyrium Fagi 247
Convolvulus 540
Coprinus 26, 379; *comatus* 26, 379; *ovatus* 379
Cordia cylindrostachya 486, 497; *ferruginea* 453, 497; *laxiflora* 453, 497
Cordiceps 73
Cordierites 71
Coreopsis 392-395
Cornus 423, 540; *Amomum* 423
Corticium 287, 292, 295, 357, 360, 429; *arachnoideum* 357; *bicolor* 427; *calceum* 360; *cremicolor* 295; *hydrians* 295; *octosporum* 360; *subcostatum* 295; *sulphurellum* 358; *sulphureum* 427; *tomentelloides* 357; *tuberculatum* 295; *vagum* 429
Corylus 540
Cotoneaster bacillaris 400
Crataegus 367, 532, 540
Creolophus 296, 297
Crepis kashmirica 404; *sibirica* 402
Cribropeltis 252; **citrullina** 252
Cronartium 61, 449, 455, 456; *andinum* 456; *eupatorinum* 456; *praelongum* 455, 456, 498; *ribicola* 400, 421; *Wilsonianum* 456
Crossospora 61, 456; **caucensis** 456, 461, 486, 497; *Wilsoniana* 449, 456
Crotalaria anagyroides 488, 497
Croton 461; *gossypifolius* 460, 497
Cryptococcus 91
Cryptodiscus angulosus 419
Ctenoderma 61
Cucurbitaria 281, 283
Cunila origanoides 250
Cuphea serpyllifolia 486, 497; *strigulosa* 486, 497
Curcas 63
Cyathula achyranthoides 486, 497
Cycledum Carpinii 144
Cydonia 540
Cylindrosporium 284; *guttatum* 425; *Ribis* 425
Cyperus 462, 497; *caracasanus* 468, 497; *diffusus* 481, 497; *ferax* 465, 488, 497; *globulosus* 468, 497
Dacryobolus 292
Daedalea 287
Daldinia 324
Daleomyces 158
Dasyscypha 420

- Dendrophoma* 246; *Zeae* 246
Dendryphium toruloides 422
Dennstaedtia rubiginosa 460, 497
Dentinum 289, 298–300
Dermatea 139, 140; *acericola* 145, 148; *carnea* 144, 145; *carpineae* 144; *Cerasi* 141; *cinnamomea* 144; *Prunastri* 141, 419; *seriata* 57
Dermatocarpon Moulinsii subpapillosum 306
Dermia 139, 140, 143; *Betulae* 142; ***Brenckleana*** 142; *Cerasi* 141
Desmella 61
Desmidiopora 72
Desmodium 492, 497; *Dillenii* 344; *mexicanum* 492, 497; *tortuosum* 492, 497
Diabole 61
Diaporthe conorum 370
Dicaeoma 475; *claviforme* 439
Dicheirinia 61, 456; *binata* 456, 498
Dichromena 468, 497; *ciliata* 468, 497; *polystachys* 468, 497; *radicans* 468, 497
Dinemasporium patellum 422; *Pezicula* 422
Diodia cymosa 472, 497
Dioscorea 63; *villosa* 255
Diospyros 540
Diplodia 275, 276, 278, 279, 281–284, 372, 546, 547; *Acubae* 548; *Aesculi* 547; *Alni* 279, 284; *cacaoicola* 538; *caryigena* 545; *Convolvuli* 546; *cynanchina* 548; *decorticata* 545; *Marsdeniae* 548; *melaena* 547; *Mori* 278; *mutila* 540–542, 546, 547; *natalensis* 279, 505, 538; *piniae corticola* 545; *quercina* 548; *Quercus* 548; *rhuiua* 548; *samararum* 548; *seriata* 544; *Theobromae* 276, 279; *vulgaris* 279
Diplodinula gallae 241; *quercina* 241
Dipsacus sylvestris 422
Dirca palustris 414
Discosia Potentillae 253
Discosporium 140
Dispira 334, 335, 337; *americana* 334; *circinata* 334; *cornuta* 333–338, 340
Dorstenia 63
Dorylaimus 260
Dothiorella gallae 507; *glandicola* 507; *longispora* 506; *quercina* 506
Draba lanceolata 405
Drosophila 162; *appendiculata* 190; *californica* 206; *campanulata* 201; *hololanigera* 180; *longipes* 202; *rigidipes* 197
Dryodon 298, 300; *luteocarneau* 366; *mucidum* 365, 366; *setosum* 366
Dugaldia 408; *Hoopesii* 408, 409
Durandiomyces 157, 158; *Phillipsii* 157
Echinodontium 286–288
Ectrogella 531; *Bacillariacearum* 531; *monostoma* 531
Eichhornia 63
Elaeagnus 540; *umbellata* 402
Eleocharis 63
Elephantopus 392–394, 454, 497; *carolinianus* 395; *mollis* 454, 497; *scaber* 454, 497; *spicatus* 454, 497
Eleutheranthera 474; *ruderalis* 474, 497
Elodea 524
Elsinoe 213, 214, 216–219; *Ledi* 215–219
Elymus canadensis 409, 410; *glaucus* 409; *striatus* 409; *virginicus* 409
Empusa 333, 335, 337
Endophylloides 61, 456; *portoricensis* 457, 499
Endophyllum 61, 457; *circumscrip-tum* 452, 457, 497; *decoloratum* 452, 453, 457, 497, 502; *guttatum* 457; *Stachytarphetae* 453, 457, 502
Endoptychum 19, 23, 25, 26; *agari-coides* 25
Endothia parasitica 549
Entomophthora 333; *sphaerosperma* 336, 337
Entophlyctis Cienkowskiana 524
Epidendrum 63, 487, 497
Epidermophyton cruris 109; *inter-digitale* 109; *lanoroseum* 111; *Per-neti* 111; *rubrum* 109–112, 115, 116; *salmoneum* 111
Epilobium roseum 399, 402
Eragrostis 469; *inconstans* 469, 497; *pilosa* 491, 497
Erigeron 468; *bonariensis* 453, 468, 497; *uliginosus* 463, 497
Eriosporangium 475
Erythrina glauca 456, 498
Erythroxyton 63
Etheiroidon 292
Euonymus 540
Eupatorium 62, 392, 455, 467, 474, 475, 481, 486, 498; *ballotifolium* 486, 498; *columbianum* 470, 498; *conyzoides* 455, 498; *densum* 486; 498; *guadalupense* 486, 498; *inuli-folium* 455, 498; *iresinoides* 486, 498; *macrophyllum* 455, 498; *mor-ri-folium* 455, 498; *nubigenum* 250; *obscurifolium* 453, 498; *odoratum* 455, 498; *perfoliatum* 250; *poma-derrifolium* 250, 455, 498; *popaya-nense* 455, 498; *pyncnocephalum* 469, 498; *Schiedeanum* 469, 498; *serotinum* 250; *tacatanum* 455, 498; *tequendamense* 455, 498;

- thyrsigerum 455, 498; turbacense 481, 498; turbacense ovalifolium 481, 498; urticifolium 250; Vargasianum 486, 498
 Euphorbia brasiliensis 495, 498; helioscopia 400; lata 494; orbiculata 493, 494, 498; pilosa 400; pilulifera 495, 498; Wallichii 400
 Eurotium 92
 Euthamia 392-394
 Eutrybliella 274
 Evolvulus villosus 472, 498
 Exidia 107
 Exolobus 475, 498
 Fagus 429; grandifolia 247
 Falcata comosa 413
 Faramea 62
 Festuca Kingii 352
 Ficus 540; Carica 454, 498
 Fimbristylis annua 470, 498
 Flammula 169, 192; alnicola 379; flvida 379; inopoda 192
 Fomes 433
 Fraxinus 426, 533, 540
 Friesites 298
 Fritillaria Roylei 406
 Fusarium 135, 140, 258, 259
 Fusicoccum Persicae 422
 Galera martipes 380; pygmaeoaffinis 380
 Galerula antipus 379; martipes 380; pygmaeoaffinis 376, 380
 Gambleola cornuta 400
 Ganoderma applanatum 432; colosum 433; lucidum 431; rivulosum 432
 Gelatinosporium 140; betulinum 57; fulvum 142
 Gentiana decumbens 403
 Geranium aconitifolium 403; hirtum 489, 498; maculatum 415; mexicanum 489, 498; multiceps 452, 464, 498; phaeum 415; pratense 403, 406, 415; pusillum 415; Wallichianum 404
 Gerbera gossypina 398
 Gibberidia 281
 Ginoria 63
 Girardinia heterophylla 398
 Gleditsia 540
 Gloeocapsa 315
 Gloeosporium 140, 217
 Gloiodon 289, 296
 Gloiothele 290
 Godronia 55; Betheli 56; striata 56
 Gomphidius 223, 235; nigricans 380
 Gonapodya polymorpha 530; prolifera 530
 Gonatorrhodiella 72
 Gossypium 454, 498; barbadense 454, 498; hirsutum 454, 498; peruvianum 454, 498; religiosum 454, 498
 Gouania 471, 498
 Grammothele 289, 290; lineata 290
 Grandinia 287-289, 291-294, 299, 356, 359; Abrotani 358; Brinkmanni 356, 359-361; crustosa 360; farinacea 293, 356, 359; granulosa 292, 356-359; helvetica 356, 357; membranacea 357, 359; muscicola 361; mutabilis 356, 358, 359; polycocca 292; raduloides 292, 356, 361
 Grandiniella 292
 Graphis **atrorubens** 312; dendritica explicans 313; scripta 313
 Gurania 492, 498
 Gymnoascus 100, 101
 Gymnoconia Rosae 401
 Gymnolomia quitensis 480
 Gymnopilus flavidellus 379
 Gymnosporangium 61; Cunninghamianum 400; **distortum** 400, 405
 Gyrodon 231, 232
 Gyromitra Phillipsii 157
 Gyrophragmium 23, 26; decipiens 23
 Gyroporus 229, 231; subalbellus 229
 Habenaria 63
 Hackelochloa 472
 Hadrotrichum Populi 213; Populi Arbuti 213, 218
 Hamelia 63
Haplochalara 347, 348; **angulospora** 347
 Harpochytrium intermedium 524
 Harposporium 519, 534; Anguillulae 261, 533
 Hebeclinium macrophyllum 455, 498
 Hedera himalaica 398
 Hedysarum cachemirianum 406
 Helianthus 393-395
 Helicoma 343; Curtisii 343; **inflatum** 344
 Helicoon fuscosporum 342; **Thaxteri** 342
 Heliopsis 464; buphthalmoides 464, 498
 Helminthosporium sativum 134
 Hemidiodia 62; ocimifolia 452, 498
 Heracleum candicans 403
 Hericium 289, 290, 298, 300; coraloides 298; croceum 366
 Hesperoyucca 24
 Heterocephalum 72
 Heterotheca 392-394; subaxillaris 394-396
 Heuchera parviflora 151
 Hexagonia 433
 Hibiscus 540
 Hicoria 540
 Hieracium crocatum 403

- Holcus lanatus* 410; *Sorghum* 477, 498
Hordeum Gussoneanum 410; *jubatum* 410; *vulgare* 403, 410
Hydnellum 300, 301
Hydnochaete 286–288, 290, 291
Hydnochaetella 291
Hydnodon 289, 290, 298, 299
Hydnopsis 290, 292
Hydnum 287–291, 293, 294, 297–299, 359; *alboviride* 362–364; *auriscalpium* 297, 298; *byssinum* 363; *calvum* 295; *chrysocomum* 364, 365; *Earleanum* 366; *farinaceum* 359; *ferruginosum* 291; *foetidum* 366; *fragile* 365, 366; *fragilissimum* 364, 365; *granulosum mutabile* 358; *helveticum* 357; *Himantia* 363, 364; *imbricatum* 299, 300; *ischnodes* 364, 365; *luteocarneau* 366; *macrodon* 365; *mucidum* 367; *niveum* 359; *ochraceum* 297; *raduloides* 361; *repandum* 298–300; *rufescens* 298; *Schiedermayeri* 366, 367; *separans* 365, 366; *setosum* 294, 366; *stenodon* 367; *strigosum* 296; *suaveolens* 301; *sub-fusum* 363, 364; *telephorum* 299
Hydrocotyle leucocephala 471, 498; *quinqueloba stella* 471, 498; *umbellata* 471, 498
Hydrophyllum capitatum 416
Hygrophorus puniceus 380
Hymenaea 63, 487, 498
Hypericum lysimachioides 399; *thesiifolium* 492, 498; *uliginosum* 492, 498
Hypholoma 160–163, 166, 169, 178, 185, 192, 204–206, 208; *aggregatum* 165, 170, 172, 186, 187; *aggregatum sericeum* 207; *ambiguum* 207; *appendiculatum* 167, 168, 171, 173, 178, 179, 182–185, 190, 207, 209; *Artemisiae* 207; *atrifolium* 166, 171, 203; *Boughtonii* 167, 168, 172, 198–201; *californicum* 171, 206; *campanulatum* 165, 172, 201; *Candolleianum* 166, 168, 170, 171, 173, 177–179, 184, 185, 190, 208; *canoceps* 167, 170, 171, 205; *canonides* 165, 172, 194; *catarium* 167, 171, 174; *cinereum* 171, 175, 176, 209; *comaropsis* 207; *comatium* 207; *coronatum* 167, 176; *cutifrac-tum* 165, 172, 190; *delineatum* 165, 172, 190, 195; *dispersum* 207, 208, 376, 380; *echiniceps* 167, 171, 172, 188; *elaeodes* 207; *elongatipes* 167, 170–173, 196; *epixanthum* 192, 207; *fasciculare* 165, 172, 194, 195; *flocculentum* 183, 207; *fragile* 167, 172, 173, 186, 189; *gracile* 207; *hirtosquamulosum* 208; *hololani-gerum* 167, 172, 180; *hydrophilum* 167, 170, 174, 179–183, 208; *hymenoccephalum* 166, 172, 173; *incertum* 161–171, 173, 177, 178, 184, 185, 190, 202; *incomptum* 205; *inocybeforme* 166, 171, 203; *irreg-ulare* 167, 168, 171, 174, 175; *lac-rymabundum* 166, 169, 170, 186, 188, 189, 191, 201, 207; *lepiditum* 191; *leucotephrum* 187, 208; *longi-gipes* 167, 172, 196, 202; *macu-latum* 167, 170, 171, 173, 205; *madeodiscum* 167, 172, 179, 180, 182; *marginatum* 208; *modestum* 208; *nitidipes* 209; *oblongisporum* 167, 170, 179, 180; *Peckianum* 167, 170, 196; *perplexum* 192; *popu-linum* 174; *radicosum* 165, 170–172, 191; *rigidipes* 166, 171–173, 197; *rugeocephalum* 167, 168, 173, 191, 198–201; *rugoproximum* 167, 171, 173, 186; *saccharinophilum* 176, 209; *silvestre* 187; *simile* 167, 170–172, 195, 196; *squalidellum* 209; *Storea* 189; *Storea caespito-sum* 187, 188; *subaquilum* 209; *sublateritium* 165, 172, 179, 180, 192–195; *sublateritium perplexum* 193; *sublateritium squamosum* 193; *tsugicolum* 167, 170, 204; *velutinum* 167, 168, 170, 171, 173, 188, 191, 197–201; *vinosum* 165, 172, 173, 185, 428
Hypochnus 290, 291, 429
Hypodendrum 387; *scabella* 387
Hypodiscus 324
Hypothele 298
Hypoxis 425; *decumbens* 489, 498; *hirsuta* 425
Hypoxylon 321, 322, 324, 326, 423; *aeneum* 326; *aeruginosum* 321–323; *albostrictum* 225; *atropurpu-reum* 324, 325; *chrysoconium* 323; *cinereo-lilacinum* 322, 324; *cro-ceum* 322, 323; *erythrostroma* 322–324; *fuscellum* 325; *fusum* 326; *haematites* 327; *haematites macrospora* 327; *haematites mi-crospora* 327; *haematostroma* 322, 326, 327; *jecorinum* 324; *Morgani* 323; *Mulleri* 322, 324; *multiforme* 325; *papillatum* 322; *placentiforme* 324; *regale* 322, 328; *regale mac-rospora* 322, 328; *rubiginosum* 322, 326, 327; *rutilum* 324; *semi-immersum* 328; *serpens* 321, 322, 327, 328; *serpens macrospora* 322, 327; *truncatum* 324; *udum* 328; *vividum* 327; *vogesiacum* 326, 327; *vogesiacum macrospora* 322, 325
Hyptis atrorubens 487, 498; *capitata*

- vulgaris 471, 498; mutabilis polystachya 471, 498; mutabilis spicata 471, 474, 499; pectinata 474, 499
 Hysterium insidens 36
 Hystrix Hystrix 410
 Ilex 277, 283, 540; vomitoria 275, 278, 279, 284
 Illosporium Mattirolanum 214, 218
 Impatiens pallida 424; Thomsoni 403
 Indigofera subulata 482, 499; suffruticosa 482, 499
 Inga 63, 483, 499; adenophylla 483, 499; edulis 483, 499; ingoides 483, 499; spuria 483, 499
 Inocybe 204, 428
 Inula subaxillaris 396; Vaillantii 396
 Ionomidotis 71
 Ipomoea 392, 393, 455, 468, 499; caloneura 455, 468, 499; carnea 477, 499
 Iresine 481, 499; paniculata 492, 499
 Irpex 286-288
 Isaria 73; acariforme 423; umbrina 423
 Isoetes 81
 Ixocomus 224, 236
 Ixora 62
 Jacquemontia 455, 499
 Jambos Jambos 477, 499
 Jasminum humile 402
 Jatropha gossypifolia 487, 499
 Juglans 540
 Juniperus 427, 540
 Jussiaea 63
 Justicia quinqueangularis 399; secunda intermedia 470, 499
 Kneiffia 292-294; setigera 294
 Kneiffiella 292
 Koeleria cristata 407-410; gracilis 410
 Kuehneola 61, 457, 458; Loeseneriana 458, 484, 493, 501
 Kyllinga 63, 487, 499; brevifolia 487, 499; odorata 487, 499
 Laboulbenia 75
 Lachnea 422
 Lachnellula chrysophthalma 420
 Laciniaria 392-394; graminifolia 394; punctata 414
 Lacrymaria 201
 Lactarius obnubilus 376, 380
 Lactuca 399; canadensis 245; decipiens 403, 404; scariola 244; spicata 245
 Lagena 264, 265; radicola 263
 Lantana camara 471, 499; hispida 452, 471, 499; tiliifolia 472, 499; trifolia 472, 499
 Larix 540
 Lasiacis 443; divaricata 444; ligulata 444; ruscifolia 490, 499; Schwartziana 445; sorghoidea 443, 445, 491, 499
 Lasiosphaeria striata 56
 Leaia 296
 Ledum 214, 216; columbianum 215; glandulosum 214-216; groenlandicum 214-216; latifolium 216
 Lemmopsis 316
 Leonotis nepetaefolia 472, 499
 Lepiota 377; americana 382; Badhami 382; brunnea 383; cuneatospora 382; eriophora 380; flameatincta 381, 382; fulvella 382; granuloides 377; haematosperma 185; **Kauffmani** 381; **pulverapella** 382; rhacodes 376, 383; roseifolia 381, 382; roseilivida 383; rugosoreticulata 378; sequoiarum 383
 Lepsanthes schizolepis 240
 Leptodon 296, 297
 Leptonia fuliginosa 384
 Leptothyrium cinctum 251; pomi 239, 250, 251
 Leucogaster 25, 28
 Liabum hastatum 472, 499; igniarum 453, 499
 Linaria canadensis 412
 Lippia 449, 462, 499; americana 462, 499
 Liriodendron tulipifera 323
 Lithospermum angustifolium 414
 Lonicera 540; parvifolia 403
 Lopharia 286-288
 Lophium 34, 39, 40; mytilinum 38, 40
 Lophodermium 254
 Lophodermopsis 254
Lophodiscella 253; **Asparagi** 253
 Loranthus 495
 Lucuma 63, 473, 499
 Lupinus 413, 454, 499; perennis 412
 Lycoperdon 17, 18, 23; axatum 14, 16, 17, 27; carcinomale 13, 15-17, 27; pedunculatum 17; pistillare 13, 15-17; stipitatum 16
 Lysimachia quadrifolia 416
 Maclura 540
 Macrophoma 423; cornina 423; Zeae 246
 Macroplodia Clematidis 546
 Magnolia 540
 Mahonia 411; Aquifolium 409, 410; nepalensis 400; repens 409
 Mainsia 458; **columbiensis** 458, 483, 501; cundinamaricensis 458, 483, 491, 501; Lagerheimii 458, 483, 493, 501; Mayorii 459, 484, 495.

- 501; *Rubi-urticifolii* 459, 484, 495, 501; *variabilis* 459, 484, 495, 501
Malus 540
Malvastrum 473, 499; *americanum* 473, 499; *corchorifolium* 473, 499; *coromandelianum* 473, 499; *peruvianum* 471, 499; *tricuspidatum* 473, 499
Mandevilla mollissima 487, 499
Manettia Toroi 453, 499
Manihot Manihot 492, 499; *utilis-sima* 492, 499
Manina 298; *Schiedermayeri* 366
Manisuris 472; *granularis* 499
Marasmius oreades 390, 391
Maravalia 72
Mariscus flavus 473, 499; *hermaphroditus* 473, 499
Marsilia 80
Marssonina 256
Marssonina 256; *apicalis* 256; *dispersa* 256; *Kriegeriana* 256, 257; *Lindii* 256; *nigricans* 256; *rubiginosa* 256; *salicicola* 256; *salicigena* 256; *salicina* 255, 257; *Salicis* 256
Martiusia rubiginosa 494, 499
Massaria 281
Medusina 298
Melampsora acidoides 400; *Heli-oscopiae* 400; *Laricis-caprearum* 400
Melanoleuca californica 390; *subannulata* 390
Melanomma 281
Melanops quercum 543
Melanthera aspera 490, 499; *aspera canescens* 490, 499
Melia 284, 540
Melica 355; *imperfecta* 355, 410
Melogramma fuliginosa 545
Melosira 514, 529; *varians* 519, 528
Mentha sylvestris 403
Merisma 298
Mertensia 267; *lanceolata* 267
Merulius 287
Mesophellia 20
Mesosetum loliiforme 350, 355
Microascus 101
Micropera 140, 142, 143; *Cerasi* 141; *drupacearum* 141
Micropuccinia Solani 435; *solanita* 435, 439
Microsphaera Russellii 420
Microsporion 109
Microthyriella 239; *philippinensis* 239; *Rubi* 237, 239
Midotis 71
Mikania 479, 480, 500; *cordifolia* 479, 480, 499; *Guaco* 457, 499; *scandens* 479, 480, 499
Milesia 61, 460; *australis* 459, 460, 496; *australis irregularis* 460; *columbiensis* 460, 500; *Dennstaedtia* 459, 460, 497
Milesina Blechni 459, 460; *columbiensis* 460; *Dennstaedtia* 459, 460
Mimosa 483; *albida* 483, 500; *putida* 483, 500; *sensitiva* 483, 500
Mitremyces 23, 26; *indicus* 14, 18, 27
Monilia albicans 91; *sitophila* 50
Monoblepharis 345, 534; *insignis* 81; *macranda* 519, 530; *macranda laevis* 530; *ovigera* 530; *polymorpha* 530; *regignens* 530; *sphaerica* 530
Montagnites 26
Morus 540
Mougeotia 532
Mucor 259, 334
Mucronella 289, 295
Mucronia 295
Muhlenbergia 350; *gracillima* 351; *montana* 350; *squarrosa* 351
Mycoleptodon 296
Mycosphaerella 239, 284
Myrcia 477, 500; *acuminata* 477, 500
Myriangium Bambusae 214
Myrioconium 266, 267, 270; *comitatum* 266
Mytilidion 34, 36, 39, 40; *Karstenii* 34, 39, 40; *laeviusculum* 38; *rhenanum* 38, 39; *scolecosporum* 34, 38-40
Myxosporium 140, 143
Myxotheca 71
Myzocytiium proliferum 532
Naucoria alniphila 384; *escharoides* 376, 385; *oregonensis* 385; *pellucida* 386
Navicula 514, 519, 524, 527
Negundo 540
Neokneiffia 292
Nephlyctis 61
Nephrolepis pendula 460, 488, 500
Neurospora 43, 46, 47, 94, 119; *crassa* 46; *sitophila* 43, 46, 50, 53; *tetrasperma* 43, 46
Neuroterus 241
Nicotiana Tabacum 418
Nitella 532
Nodularia acericola 144
Nolanea mammosa 386; *pasqua* 386
Nowakowskiella 527; *elegans* 528, 532
Nyctalis asterophora 427; *parasitica* 427
Nyssa 429
Ocellularia domingensis 314; *floridensis* 314
Ochropsora Sorbi 400
Odontia 287-290, 292-294, 299; *Brinkmanni* 360; *cristulata* 293;

- crocea 364, 365; farinacea 359;
 fimbriata 293; fuscoatra 368; hi-
 mantia 363; hydroides 292; mac-
 rodon 365, 366; mutabilis 358;
 nivea 359; olivascens 358; Pruni
 293; stenodon 367, 368; uda 368
 Odontina 292
 Oedogonium 514-516
 Olivea 61
 Olpidiopsis Oedogoniorum 514, 516;
 Saprolegniae 515
 Olpidium 515; entophytum 515
 Onagra 540
 Opegrapha 311-313
Opegraphoidea 311; staurotheli-
cola 311
 Operculina 63
 Oplophora Cedrelae 400
 Opulaster 540
 Opuntia 540
 Oreomyrrhris andicola 478, 500
 Ornithidium 63
 Oryctanthus 495; botryostachys 495,
 500
 Oryzopsis micrantha 411; miliacea
 408, 410, 411
 Oscillatoria 514, 517, 519, 528
 Ostrya 427, 540
 Otthia 281
 Oxalis 413, 420, 475, 500; cornicu-
 lata 412, 413; europea 413; pubes-
 cens 475, 500; stricta 413
Oxydonta 288, 289, 293, 294, 356,
362; albobiridis 294, 295, 362, 364;
fragilissima 294, 362, 364, 368;
himantia 294, 362, 363; macrodon
294, 362, 365; setosa 294, 362,
366; stenodon 294, 362, 367
 Oyedaea 476; buphthalmoides 475,
 500
 Panaeolus 202; campanulatus 7
 Pandorina 519
 Panicum 442-444, 450; altissimum
 442, 443, 445; barbinode 443, 444,
 493, 500; fasciculatum 443; jav-
 anicum 443, 444; lanatum 442, 487,
 491, 500; trichoides 444
 Panus operculatus 427
 Parsonsia 63, 486, 500; Pinto 486,
 500; racemosa 486, 500
 Parthenium 392-394
Paspalomyces 345; aureus 345
 Paspalum 345; conjugatum 481, 500;
 conspersum 349; dilatatum 349;
 Fournierianum maximum 472, 500;
 Humboldtianum 481, 500; macro-
 phyllum 466, 500; paniculatum 349,
 481, 500; pilosum 472, 500; pro-
 stratum 463, 500; Urvillii 349
 Patinella Brenckleana 142
 Pavonia paniculata 482, 500
 Paxillus 223, 235; panuoides 386
 Pedicularis bracteosa 269; groen-
 landica 269
 Penicillium 90-94, 96, 97, 99-103;
 aureum 100; avellaneum 101; ba-
 cillosporium 98, 100; **Brefeldianum**
 92-103; glaucum 90, 101-103; ja-
 vanicum 91, 97, 98, 100, 101, 103;
 luteum 94, 98, 100, 101, 103; Pet-
 chii 100; Sacchari 100; spiculispo-
 rium 101; Wortmannii 100, 101
 Peniophora 293, 294; setigera 294
 Pennisetum bambusiforme 466, 500
 Pentstemon 413; alpinus 413; gen-
 tianoides 413; hirsutus 244, 412,
 413; laevigatus 413; secundiflorus
 412
 Peperomia 63
 Peridermium 395; excelsa 400; Fi-
 cariae 418; Hyoscyami 418; orien-
 tale 401; Piceae 401
 Persicaria hydropiperoides 476, 500;
 persicarioides 476, 500; punctata
 476, 500
 Pezicula 139, 140, 143; acericola 144,
 146, 147, 421; carpineae 143; pru-
 inosa 143, 146; **spiculata 146, 148**
 Peziza carpineae 139, 143; Cerasi 139,
 141; cinnamomea 144; proteana
 157; Prunastri 141
 Phacidium seriatum 56
 Phaeodon 290, 291
 Phaeographina 313; columbiana 313;
 explicans 313
 Phaeoradulum 295
 Phakopsora 61, 460, 461; aescyno-
 mensis 460, 484, 496; columbiana
 460, 497; Vignae 461, 488, 501,
 Vitis 449, 456, 461, 502
 Phallo-gaster 72
 Pharbitis 393, 394
 Phaseolus lunatus 489, 500; vestitus
 489, 500; vulgaris 489, 500
 Phellodon 300, 301
 Phellorinia 24-26, 28; californica 24;
 Delestrei 6, 25; inquinans 25;
 macrospora 24; strobilina 25
 Phlebia 286-288
 Phleum 540; pratense 476, 500
 Phlomis setigera 402
 Phlox 416; divaricata 415, 416
 Phlyctidium 517, 518, 523; **anatro-**
 pum 516, 518; anomalum 518;
 breviceps 518; Bumilleriae 518;
 Chlorogonii 518; Eudorinae 518;
 laterale 518; **Olla 514, 517; spinu-**
 losum 514, 516, 518
 Phlyctochytrium 514, 518, 523; bipo-
 rosum 514, 518, 522; dentatum
 529; quadricorne 514, 516, 523;
 vernale 518; Zygнематис 514, 523,
 529

- Pholiota 163, 428; duroides 209, 387; ornella 209; **scabella** 386
 Phoma 284, 372, 537; abietina 374; Douglasii 372; malorum 537; Pini 371; poolensis 244; spermoides 423
 Phomopsis 246, 369-375; abietina 374; juniperovora 370, 374; **Lo-koyae** 371-375; occulta 370, 374; Pseudotsugae 369-371, 374, 375; Strobi 370
 Phragmidium 461; Barclayi 401; Butleri 401; disciflorum 401, 461, 500; **Kamtschatkae** 401; Potentillae 401; Rosae 401; Rosae-moschatae 402
 Phragmothyriella **Sydowii** 239
 Phthirusa pyrifolia 494, 500
 Phylacteria 287, 291
 Phyllanthus 62
 Phylloporus 223, 235
 Phyllosticta 241, 244, 245, 284, 425; agrifolia 242; **Anserinae** 243; Antirrhini 244; Dearnessii 243; decidua 245, 246; Desmodii 243; **dispergens** 242; fragaricola 243; Lactucae 245; livida 242; ludoviciana 242; macroguttata 244; Meibomia 243, 244; Mulgedii 245; **neuroterigallicola** 240, 241; potentillica 243; quercea 242; Quercus 242; Quercus-ilicis 242; Quercus-prini 242; Quercus-rubrae 242; querneae 242; **scariolicola** 245; Smilacis 240; tumoricola 241; variabilis 243; vesicatoria 241; virescens 242; Wislizeni 242
 Physalospora 276, 278-280, 283, 284, 504, 505, 543; Cydoniae 542, 544; **glandicola** 504, 507; malorum 542, 544; obtusa 540-543, 546; Rhododendri 420
 Phytolacca decandra 422
 Picea 387; sitchensis 380; Smithiana 399, 401
 Pilobolus 85, 334
 Pilosace 160
 Pimpinella diversifolia 403
 Pinnularia 530, 531
 Pinus 35, 39, 40, 393, 519, 540; Banksiana 420; caribaea 392, 393; cembra 232; contorta 386, 387, 393; echinata 392; excelsa 400; longifolia 401; palustris 392, 393, 395; ponderosa scopulorum 393; Strobilus 34, 232, 421, 428; taeda 392, 393
 Piper antioquiense 488, 500; Hartwegianum 488, 500
 Pisonia 62
 Pithecellobium 483
 Pithecolobium lanceolatum 483, 500
 Plantago lanceolata 418; Rugelii 247; virginica 418
 Plasmopara 446; Halstedii 446, 447
 Plasmophagus 515; Oedogonium 513-515
 Platanus 540
 Pleolpidium 515
 Pleospora 100, 281
 Pleurococcus 304-306, 310
 Pleurodon 296-298
 Pleuropus 297
 Pleurotus limpidus 376, 387
 Plumiera 454, 500; alba 454, 500; rubra 454, 500
 Poa annua 469, 500; palustris 410; pratensis 410, 469, 500
 Podaxis 1-4, 6-10, 19, 20, 22-28; axata 14, 17, 18; carcinomalis 12, 16, 26; Farlowii 15, 22, 23, 27; pistillaris 13, 15, 16, 18, 19, 23, 26, 27; senegalensis 14, 18, 27
 Podaxon 1, 12, 13, 15, 22, 24, 26; aegyptiacus 12, 14, 19; algericus 14, 21, 27; anomalus 4, 15, 22, 27; arabicus 8, 12, 14, 20, 27; argentinus 15, 21, 27; calyptratus 14, 16, 18, 27; calyptratus minor 14, 19; carcinomalis 9, 12, 13, 19, 20, 22, 23; carcinomalis minor 12, 14, 16, 21; Chevalieri 14, 21, 27; Deflersii 14, 20, 27; elatus 14, 19, 21, 27; Emerici 14, 20, 27; Farlowii 11; Farlowii gracilis 15, 23; Ferrandi 15, 22, 27; ghattasensis 15, 21, 27; Glasiovii 15, 21, 27; Gollani 15, 21, 27; indicus 14, 18; loandensis 14, 19, 27; macrosporus 15, 21, 27; mexicanum 11, 15, 21, 27; mossamedensis 14, 19, 27; mossamedensis Emini 14, 19; Mülleri 15, 21, 27; Paoli 15, 22, 27; patagonicus 15, 21, 27; Perraldieri 14, 21, 27; pistillaris 10, 13; Schweinfurthii 14, 20, 27; squamosus 13, 14, 20, 22, 27; strobilaceus 15, 23; termitophilus 15, 22, 27; Warnei 14, 19, 23
 Podochytrium clavatum 514, 524
 Podophyllum peltatum 425
 Polemonium 416; reptans 415, 416
 Polyblastiopsis **dealbens** 307; **floridana** 307; lactea 307
 Polygala 413; Senega 412, 416
 Polygonum 414; acre 476, 500; aviculare 406; emersum 415; filicaule 403; tortuosum 403; virginianum 414, 415
 Polymnia glabrata 494, 500
 Polyporus 287
 Polyrhina multififormis 534
 Polystictus 287
 Polytænium 63

- Pomolobus pseudoharengus 339
 Populus 256, 429, 540, 547; alba 400; nigra 213
 Poria 287; lamellosa 290
 Porina cestrensis **platyspora** 308; nucula **heterospora** 308; olivacea **microspora** 308
 Porphyrellus 223, 235
 Potentilla 270, 271; Anserina 243; canadensis 253, 271; fragarioides 401; Kleiniana 401
 Prescottia 63
 Propolidium fuscocinereum 419
 Prospodium 61, 461; appendiculatum 449, 461; Von Guntenii 449, 461-463, 482, 499
 Prunus 142, 419, 540; americana 250; emarginata 142; pennsylvanica 142; Persica 251, 422; serotina 251, 276
 Psalliotia 160, 428; augusta 376, 387, 388; **cervinifolia** 388; comptuloides 389; dulcidula 376, 388; echinata 185, 428; haemorrhodaria 388; sanguinaria 388; silvatica 388; subrufescens 387; subrutiles-cens 389
 Psathyra 160, 162, 206, 207; echinata 428
 Psathyrella 162
 Psedera 540
 Pseudolpidium incrassatum 515
 Pseudotsuga 24; taxifolia 369, 371-373, 375, 383, 427
 Psidium 477, 500
 Psilocybe 160, 209; larga 197
 Psilospora 254
 Psoralea Onobrychis 416
 Psorotichia arnoldiana 316; **Hasse** 315; Schaererii 316
 Ptelea trifoliata 414
 Pteridium aquilinum 484, 500
 Pterula 295
 Puccinia 61, 435, 437, 444, 450, 469, 473; abrepta 462, 497; absicca 482; Absinthii 402; Ainsliaeae 402; al-bida 462, 476; Ancizari 462, 474, 496; Andropogonis 412-414; Anoda 462, 496; antioquiensis 462, 481; appendiculata 462, 463; Archavaletae 463, 497, 501; argentata 402; Arrhenatheri 410, 411; Asparagi 251; Asteris 463, 468, 497; Asterum 254, 453, 468; atra 463, 500; aulica 436, 437, 439; Baccharidis rhexioides 463, 496; Ballotaeflorae 449, 463, 464, 478, 488, 501; Barbevi 402; Barranquillae 464, 474, 501; Batesiana 464; Beckii 464, 502; Bimbergi 452, 464, 498; Blechi 478; Bocconiae 464, 496; bogotensis 464, 498; boliviana 476; Bomareae 452, 464, 496; Bombacis 465, 496; Bupleuri-falcatae 402; caeomatiformis 465, 496; Caleae 449, 465, 485, 497; Calthae 402; Cameliae 465, 485, 497; canaliculata 465, 497; Cannae 497; Capsici 466, 497; Caricis 405; Cenchri 466, 497, 500; Chaerophylli 402; Chaetochloae 466, 500; Chamaesarachae 439; Chaseanum 466, 496; Chrysopogi 402; Circaeae 402; claviformis 436, 437, 439, 440, 466, 467, 471, 479, 501; Cle-matidis 467, 496, 502; Conoclini 467, 484, 486, 487, 496; **conspicua** 408; conturbata 467, 501; Convolvulacearum 467, 479, 480; coronata 402; crassipes 468, 471, 499; Crepidis-sibericae 402; cundinamar-censis 468, 470; curtipes 151; Cy-nodontis 468, 497; Cyperi, 452, 453, 468, 497; Dichromenae 468, 486, 497; distinguenda 477; Doloris 463, 468; dubia 468, 479, 480; Duthiae 402; Eleutherantherae 469, 474; Ellisiana 413, 414; Epi-lobii-tetragoni 402; epiphylla 469, 500; **eragrostidicola** 469, 497; Eragrostidis 469; Eupatorii 469, 486; Eupatorii-columbiani 470, 486, 498; eupatoriicola 469, 498; evadens 470, 496; examinata 470; excelsa 402; extensicola 402; ferox 468, 470, 478, 502; Festucae 403; filop-es 470, 497; Fimbristylidis 470, 498; Fuhrmanni 470, 499; Gen-tianae 403; Geranii-silvatici 403; glumarum 403, 410, 411, 470, 502; Gonzalezi 470, 497; Gouaniae 471, 498; graminis 403, 476; Gymnolomaiae 480; Heraclei 403; heterospora 462, 471, 496, 499, 501, 502, 510, 512; Hieracii 403; Hieronymi 436, 438; Holwayia 475, 476; huallagensis 435, 436, 439, 466, 467, 471; Huberi 444; Hydrocoty-les 471, 498; Hyptidis 471, 498; Hyptidis-mutabilis 471, 498, 499; imitans 436-438; impedita 471, 501; improcera 485; incondita 436, 437, 441; interveniens 411; Ipomoeae-panduratae 468, 471; Kamschatkae 401; Koeleriae 409-411; Komarovi 403; Lantanae 471, 499; lateritia 472, 496, 497; Leonotidis 472, 499; leontidicola 472; levis 444, 472, 476, 496, 500, 501; Liabi 472, 499; Liatridis 408; Lithospermi 472, 498; **Lucumae** 473, 499; macronoda 473, 481; Mal-vacearum 473, 479, 499, 501, 509; Marisci 473, 499; Maydis 474,

- 479; Mayerhansi 462, 474, 496; medellinensis 474, 499; Melampodii 464, 469, 474, 480-482, 497, 501, 502; Menthae 403, 474, 499; micrantha 411; monoica 407, 408; montanensis 410, 411; monticola 403; Montoyae 474, 496; Montserratensis 474, 496; nariñensis 475, 498; Negeriana 436-438; nepalensis 403; obliqua 475, 498; Opizii 403; Ortizi 475, 496; Oxalidis 475, 500; Oyedaeae 475, 500; pallescens 476, 502; pallidissima 462, 476, 501; paramensis 476, 501; Paspali 472, 476; paulensis 452; Pimpinellae 403; Pittieriana 436-438, 441, 476, 501; Poae-sudeticae 469; Porarum 469; poculiformis 476, 496, 500-502; Pollinia 403; Polygoni-amphibii 404, 414, 415, 476, 500; praecox 404; Prenanthes-purpureae 404; propinqua 404; Pruni-spinosae 476, 484; Psidii 477, 487, 499, 500; Pulsatillae 404; punctata 477, 500; purpurea 477, 498; puta 477, 499; Rhamni 477, 496; Rivinae 477, 500; Rosae 401; rotundata 477, 478, 502; rubigo-vera 399, 404; Ruelliae 478, 485, 496; rugosa 477, 478; ruizensis 478, 500; salviicola 449, 463, 464, 478; Samperi 478, 497; sana 476; Sarachae 478, 501; Saxifragae-ciliatae 404; Schistocarphae 478, 501; Scleriae 478, 479, 495, 501; sclericola 478; Sidaerhombifoliae 473, 479; silvatica 398, 405; **silvaticella** 404, 405; Smilacis 479, 501; Solanacearum 436, 437, 439; Solani 435-440, 467; Solani-tristis 436, 437, 440, 441; solanicola 435, 436, 439, 466, 467, 479; solanita 435, 436, 439, 466, 467, 479; soledadensis 479, 501; Sorghi 413, 474, 479, 502; Spegazzinii 467, 468, 479, 499, 500; spilanthisicola 474, 480, 501; Steiractiniae 449, 452, 480, 501; Stipae 408; striolata 473, 480, 499; subcoronata 462, 481, 497; subdigitata 481, 496; substerilis 411; substriata 481, 487, 497, 500; Swertiae 405; Synedrellae 474, 481; tageticola 481, 501; Thlaspeos 405; tolimensis 474, 481, 498; Trollii 405; tubulosa 440, 481, 488, 500; tuyatensis 472; Vernoniae-mollis 455, 481, 502; Viola 406; Von Gunteni 462, 482; Wattiana 406; Wedeliae 474, 482; Windsoriae 414; **zemeniicola** 482, 502
- Pucciniastrum 61
- Puccinosira 61, 482; pallidula 482, 499, 500, 502
- Pucciniostele Clarkiana 406
- Pueraria 540
- Pycnodon 292
- Pyrenopsis 315; fuscoatra 315; **le-cideella** 314
- Pyrenula dealbens 307; **Herrei** 309; nitida 309
- Pyronema 95
- Pyrus 540
- Pythiogeton transversum 533
- Pythiomorpha gonapodioides 533
- Pythium 263, 337, 533; dictyosporum 534; gracile 534; tenue 533
- Quamoclit 393; angulata 455, 500; coccinea 455, 500
- Quercus 426, 427, 429, 540; imbricaria 241; montana 328
- Radulum 289, 295; orbiculare 295; pendulum 295
- Rajania 63
- Ramularia 284; Impatientis 424
- Randia 62
- Ranunculus recurvatus 418
- Ravenelia 61, 482; Indigoferae 482, 499; Ingae 483, 494; Mainsiana 483, 500; **Mimosae-pudicae** 483, 500; Mimosae-sensitivae 483, 500; Pithecolobii 483, 500
- Relbunium hypocarpium 477, 500
- Resupinatus 288, 293
- Rhabditis 260
- Rhacophyllus 26
- Rhamnus purpureus 402; virgatus 402
- Rhipidium 81; americanum 532
- Rhizoctonia 259
- Rhizophidium 517, 518, 520-523, 525, 526, 528; anatrosum 516; carpophilum 519; digitatum 529; dubium 520; Fuscus 519; gibbosum 519; globosum 519, 522; goniosporum 522; mamillatum 525; pollinis 519, 521; rostellatum 523; setigerum 526; simplex 519; sphaerocarpum 518-520, 534; von Min-denii 526
- Rhododendrum maximum 420
- Rhus 275, 277, 278, 280, 282-284, 540
- Rhynchosia longeracemosa 500
- Rhytidhysterium 274
- Ribes 412, 540; aureum 412; Cynosbati 412; floridum 412; nigrum 412; orientale 400; oxacantha 412; rubra 506; vulgare 425
- Ricciolepus fluitans 80; natans 80
- Ricinus 540
- Rickia 74; Wassmanni 74
- Rivina humilis 477, 500

- Robinia 540
 Rosa 401, 461, 500, 530, 540; macrophylla 401, 402; moschata 402; Webbiana 401, 402
 Rousselia 63
 Rubus 238, 239, 458, 459, 501, 540; adenotrichos 459, 501; argutus 238; flagellaris 243; glaucus 459, 501; lasiocarpus 401; odoratus 243; peruvianus 458, 501; triflorus 243; urticifolius 458, 459, 501
 Rudbeckia hirta 447; laciniata 416
 Ruellia 478
 Rumex acetosa 403
 Russula 389, 427; fallax 389; furcata 389
 Rynchosia longeracemosa 491
 Rynchospora polyphylla 489, 501
 Rytillix granularis 472, 501
 Sabicea 63
 Salix 56, 203, 256, 266, 267, 270, 400, 419, 421, 540; cordata 256; discolor 256; longifolia 256; nigra 256; petiolaris 256; syrticola 256
 Salvia 449, 467, 485; cataractarum 463, 501; cernua 476, 501; latens 485, 501; leucocephala 476; Mayorii 463, 501; palaefolia 467, 501; pauciserrata 479, 501; petiolaris 463, 471, 501
 Sambucus 540
 Sapota 63
 Saprolegnia 519
 Saracha edulis 478, 501; Jaltomata 478, 501
 Sarcodon 287, 291, 299, 300
 Sassafras 540
 Sauvagesia 63
 Savia 63
 Saxifraga ciliata 404; Stracheyi 404
 Schistocarpus 478, 501
 Schweinitzia 18, 24; carcinomalis 13, 18; pistillaris 13
 Scirpus 406, 248; atrovirens 248
 Scleria 479, 501; melaleuca 478, 479, 501; neogranatensis 479, 501
 Scleroderma 16, 18, 24; carcinomale 13; pistillare 13
 Scleroderris 55; acerina 144; fuliginosa 55; seriata 56, 57
 Sclerodon 296
 Sclerophoma 372; Douglasii 372
 Sclerotinia 266, 267, 271, 272; coloradensis 266, 268; Duriaana 272; fallax 270, 271; foliicola 266, 269; gregaria 266, 270; paludosa 271; Rathenowiana 270; sclerotiorum 267, 269; utriculorum 271, 272; Veratri 266, 267
 Sclerotium 266; bifrons 266; fallax 270, 271
 Scopulariopsis 101
 Secale cereale 410
 Secotium 19, 25, 26, 28; agaricoides 25, 26; erythrocephalum 25; Novae-Zelandiae 25; tenuipes 25; Warnei 19
 Segestria floridana 308
 Senecio 393; chrysanthemoides 398; cruentus 446, 447
 Septonema 34, 36-41; spilomeum 36, 37; toruloideum 34-36, 38, 40
 Septoria 284, 424, 425; albomaculans 250; alliorum 426; astericola 424; Callistephi 424; Cerastii 424; Cunilae 249; Eupatorii 250; eupatoriicola 250; Hypoxi 425; podophyllina 425; Ribis 425; sibirica 425; Speculariae 426; viriditingens 426
 Serjania 463, 501; brevipes 463, 501; membranacea 463, 501
 Setaria scandens 465, 501
 Sida 510; rhombifolia 471, 473, 501; spinosa 471, 501
 Sidalcea candida 407, 411, 412
 Silphium 393, 394
 Sistotrema 286-288
 Sitanion Hystrix 410
 Smilax 240, 495, 501, 540; cumanensis 479, 501; hispida 255; rotundifolia 240
 Solanum 62, 435, 436, 438-441, 450, 466, 467, 488, 495, 501; diversifolium 440; Donnell-Smithii 440; Dulcamara 422; furcatum 438; hirtum 440, 466, 501; incisum 438; montanum 439; myrianthum 440, 466, 501; Neves-Armondii 441; ovalifolium 440, 466, 501; rufescens 441; straminifolium 440, 466, 501; torvum 440, 466, 501; triquetrum 441; tristis 441; tuberosum 438, 476, 501; utile 438
 Solidago 393-395; canadensis 254; rigida 411, 412
 Sommerstorffia spinosa 532, 533
 Spartina Michauxiana 415
 Spathiger 63
 Specularia perfoliata 426
 Sphaceloma 213-219; Mattirolanum 214, 218; Populi 213; Symphoricarpi 217-219
 Sphacelotheca Andropogonis 354; columellifera 353; inconspicua 354; Ischaemi 354; Macrothricis 354; montaniensis 351; occidentalis 354; Trachypogonis 353
 Sphaeria albo-farcta 544; Amorphae 547; ampelos 544; druparum 544; dubia 141; fuliginosa 55; pallae 506, 507; glandicola 507; Gleditiae 544; junipericola 544; Loni-

- cerae 544; malorum 536, 547;
 meloplaca 544; mutila 547; obtusa
 543; pericarpium 544; pyrina 544;
 quercuum 505, 538; ruina 544;
 saepincola 544; subfasciculata 544
Sphaeronema 140, 143, 146; acer-
 inum 144-147; nigripes 144; pru-
 inosa 143, 146; seriatum 57; spu-
 rium 141, 420
Sphaerophragmium 61
Sphaeropsis 423, 536, 546; abundans
 545; *Ailanthi* 545; *Aristolochiae*
 546; *Ceanothi* 546; *cerasina* 545;
Clematidis 546; *clethraecola* 545;
Cydoniae 545; *cylindrospora* 547;
Diospyri 548; *fertilis* 545; *fibri-*
seda 545; *fusiger* 544; *gallae* 507;
hyalina 506, 507; *Juglandis* 546;
Maclurae 545; *Magnoliae* 546;
 malorum 536, 537, 542, 543, 545,
 546, 548; *Negundinis* 546; *Oeno-*
therae 545; *opaca* 545; *parallela*
 546; *pennsylvanica* 544; *Persicae*
 546; *Phlei* 545; *phomatella* 545;
Physocarpi 545; *Platani* 544; *po-*
marum 546; *Populi* 545; *pulvin-*
acea 546; *punctata* 546; *Punctum*
 545; *quercina* 506, 507; *ribicola*
 544; *Robiniae* 545; *rosarum* 545;
rubicola 545; *semitecta* 546; *seri-*
atus 545; *sociata* 547; *subcuticu-*
laris 546; *Sumachi* 544; *tephro-*
spora 544; *tiliacea* 545; *triacanthi*
 545; *ulmea* 545; *Viburni-dentati*
 546
Sphenopholis obtusata 410
Spilanthus 474; *americana* 480, 501;
ciliata 480, 501; *urens* 464, 501
Spirechina 458; *columbiensis* 458,
 483; *cundinamarcensis* 458, 483;
Lagerheimii 458, 483; *Loeseneri-*
ana 458, 484; *quitensis* 459, 484;
Rubi-urticifolii 459, 484; *variabilis*
 459, 484
Spirogyra 514, 515, 517-520, 522,
 529, 532, 533
Sporobolus 63
Sporodinia 338, 339
Stachys Mayorii 476, 501
Stachytarpheta cayennensis 457, 501
Stagonospora 248; *aquatica* 248;
aquatica junciseda 248; *aquatica*
Karstenii 248; *aquatica lacustris*
 248; *aquatica sexseptata* 248; **sex-**
septata 248; **Scirpi** 247, 248;
scirpicola 248
Staurothele umbrina 312
Steccherinum 289, 290, 296, 297; *ad-*
ustum 297; *lacticolor* 293; *ochra-*
ceum 293; *pulcherrimum* 297;
reniforme 297
Steiractinia 480, 501; *Rosei* 480
Steironema 416; *ciliatum* 415, 416;
lanceolatum 416
Stellaria media 419
Stenorrhynchus 63
Stereum Pini 428
Stictis 55
Stigeoclonium 514, 517, 525, 526
Stipa 407, 411; *comata* 408; *lepidia*
 408; *Lettermani* 411; *minor* 407,
 411; *Neesiana* 476, 501; *pulchra*
 407, 408, 411; *viridula* 407, 408,
 411
Strobilanthes dalhousianus 403
Stropharia 160; *ambigua* 207; *psa-*
thyroides 376; *semiglobata* 7; *si-*
enna 387
Struchium 63
Swertia petiolata 405; *speciosa* 405
Symphoricarpos albus laevigatus 217
Synchytrium 453; *aureum* 419; *citri-*
num 451; *plantagineum* 418; *Stel-*
lariae 419
Synedrella 474; *nodiflora* 474, 501

Tabellaria 514, 528
Tagetes microglossa 501; *patula* 501
Taphrina 71
Taraxacum officinale 404
Taxus 540
Tecoma 62
Teleconia Rosae 401
Teramnus uncinatus 461, 501
Tessaria integrifolia 494, 501
Thalictrum 423; *dioicum* 416; *minus*
 404
Thecopsora 61
Thelephora granulosa 358; *setigera*
 293
Thelidiella 305, 312; **blastenicola**
 305
Thelidium 305-307; *distans* 307
Thelotrema lapadodes 314
Thielavia 103; *Sepedonium* 98, 101,
 102
Thielaviopsis 346, 347
Thraustotheca clavata 532
Thyridaria 281
Tilia 540
Tilletia fusca 353; *Muhlenbergiae*
 351; *Vulpiae* 352
Tomentella 287, 291
Torulinum ferax 488, 502
Tournefortia 62
Trachypogon canescens 353; *mollis*
 353; *Montufari* 353; *vestitus* 353
Tradescantia cumanensis 490, 502;
multiflora 490, 502
Tranzschelia 61, 484; *punctata* 476,
 484, 496
Tremella 108; **gangliformis** 108;
mesenterica 107
Tremellodon 288

- Trentepohlia 304, 307-314
 Tribolium seriatum 57
 Tribonema 514, 515, 522; bombycinum 513
 Trichilia 63
 Trichobasis Oxalidis 475
 Tricholoma 391; amplum 376, 389; californicum 390, 391; ionides 390; sordidum 390, 391; subannulatum 390; subpessundatum 391
 Trichophyton 109-111; purpureum 109-112, 115, 116; rubidum 110
 Trichosporium umbrinum 423
 Tridens flavus 414
 Trifolium repens 494, 502; resupinatum 406
 Trisetum sequiflorum 410; spicatum 407, 408; subspicatum 407, 408
 Triticum 404; aestivum 467, 470, 476, 502; vulgare 410
 Triumfetta 482, 502; semitriloba 482, 502
 Tryblidiella 274, 276, 278-281, 283; elevata 278; hystera 275, 277-279, 283, 284; Leprieuri 276, 277, 282-284; rufula 275-278, 280, 282-284
 Tryblidium 274; calyciforme 274; hystera 274
 Tsuga canadensis 426
 Tuberculariella 140; fasciculata 143
 Tulasnella 428; Eichleriana 429; fusco-violacea 429; violacea 429
 Tulostoma 26
 Tylodon 295
 Tylopilus felleus 223
 Tympanis acerina 144-146, 421; alnea 421; Cerasi 141; Pinastri 421; Prunastri 141; saligna 421
 Typha 528
 Tyrodon 298
 Ulmus 540
 Uncinula 71
 Uredinopsis 484; macrosperma 484, 500; Mayorianae 484, 496; Pteridis 484
 Uredo 61, 62, 442, 450, 465, 484; Aeschynomenis 460, 484; Agerati 467, 484; amarae 484, 492; amica 62; Andronogi 354; anisoderma 485, 489, 502; Anthurii 62, 485, 496; Archeriana 485, 501; Artocarpi 485, 496; Baccharidis-anomala 485, 496; balaensis 478, 485; bauhiniicola 62; Bixae 62; Bomareae 464; Borreriae 62; Buchenaviae 62; bullula 62; Cabreriana 456; Caleae 449, 465, 485; Cameliae 465, 485; Campeliae 62; caucensis 448, 449, 456, 461, 486; Cephalanthi 62; Chardoni 62; Cherimoliae 62, 486, 496; Clusiae 62; Coccolobae 62; concors 461; Cordiarum 486, 497; cumula 63; cundinamarcensis 486, 496; Cupheae 63, 486, 497, 500; curvata 63; Cyathulae 486, 497; Dichromenae 468, 486; dioscoreicola 63; egenula 63; Eichorniae 63; Erythroxylois 63; Eupatorium 467, 469, 486, 487, 498; Gossypii 453, 487; Guacae 63, 487, 497; guaynabensis 63; Gynandrearum 63; Hameliae 63; Henningsii 442, 481, 487, 491; Hymenaeae 63, 487, 498; Hypoxidis 487, 489; Hyptidis-atrorubentis 487, 498; ignava 63; incomposita 63; jatrochicola 63, 487, 499; Kyllingiae 63, 487, 499; laeticolor 63; Loeseneriana 458; Lucumae 63, 473; lutea 63; Mandevillae 487, 499; Myrciae 477, 487; Nephrolepidis 488, 500; nigropuncta 63; nociviola 488, 497; Ornithidii 63; Oxalidis 475; paspalicola 481, 488; Peperomia 488, 500; Piperis 488, 500; Polytaenii 63; pustulata 63; Rousseliae 63; rubescens 63; sabiceicola 63; Salviarum 449, 463, 488; Sapotae 63; Sauvagesiae 63; Saviae 63; Scabies 488, 502; Sparganophori 63; Teramni 461, 488; Theresiae 488, 497; tolimensis 488, 501; Toriana 63; Torulini 488, 502; Trichiliae 63; uncinata 63; unilateralis 452, 489, 492, 498; Valerianae-Wallichii 406; Vernoniae 485, 489; vicina 63; Wilsoni 63; Zeugitis 489, 502
 Urocystis 355; Agropyri 355; Bornmulleri 355; Heucherae 150, 151; Lithophragmae 151
 Uromyces 61, 442, 444, 450, 489, 491, 494; Aconiti 406; acuminatus 415, 416; affinis 487, 489, 498; Andropogonis-annulati 406; appendiculatus 489, 495, 500; antiokiensis 489, 501; Asclepiadis 489, 496; bidenticola 490, 496; Bidentis 490, 496; Cestri 490, 497; Cissampelidis 490, 497; columbianus 490, 499; Commelinae 490, 495, 502; costaricensis 442-444, 487, 490, 491, 493, 499; Crucheti 491, 496, 500; cundinamarcensis 458, 491; Dolicholi 491, 500; Eragrostidis 469, 491, 497; eunhorbiicola 491, 495; Fabae 491, 502; Fritillariae 406; Geranii 406, 489, 492; Guaraniae 492, 498; Hedysari-obscuri 406; Hedysari-naniculati 484, 492, 497; Hyperici-frondosi 492, 498; Iresines 492, 499; Janiphae 449,

- 492, 493, 499; Lagerheimii 458, 493; largus 494; leptodermus 442-444, 491, 493, 500; Loesenerianus 458, 493; Lucumae 473; Manihotis 449, 492, 493; Mayorii 493, 494, 498; megalospermus 494, 501; nerviphilus 494, 502; Neurocarpi 494, 499; oblectaneus 489; Phtirusae 494, 500; Polygoni 406; Polymniae 494, 500; porcensis 483, 494; proëminens 491, 493, 494, 497; quitensis 459, 495; Rhyncosporae 489; Rubi-urticifolii 459, 495; Scirpi 406; Scleriae 479, 495; Smilacis 495, 501; Solani 495, 501; Spegazzinii 490, 495; Trifolii 406; Urbanianus 495, 496, 500; **Valerianae-Wallichii** 406; variabilis 459, 495; Vignae 489, 495, 502
- Urtica 405
- Ustilago 354; Bethelii 350; carbo columellifera 353; coloradensis 351, 352; Festucae 352; Goyazana 350; Hieronymi 351, 352; mexicana 350; Muhlenbergiae 351; Mulfordiana 352; Paspali-dilatati 349; **Pseudohieronymi** 351; Schröteriana 349; sphaerocarpa 352; striaeformis 352; Zeae 337
- Valeriana pyrolaeifolia 406; Wallichii 406
- Valerianodes cayennense 457, 502
- Valsa etherialis 421; leucostoma 423
- Vanilla planifolia 488, 502
- Varronia 62
- Vaucheria sessilis 533
- Veluticeps fusca 429
- Veratrum californicum 268
- Verbesina 393, 394, 470, 478, 502; laciniata 395; nudipes 470, 502; verbascifolia 470, 502
- Vernonia 63, 392-395, 478, 482, 502; brasiliana 477, 502; Cotoneaster 464, 502; mollis 455, 482, 485, 502; patens 477, 502; scabra 478, 502
- Verrucaria 304, 305; aethiobola 304; distans 307; margacea 304; nigrescens 304, 305; **nigrescentoidea** 303; silicola 305; **subsuperficialis** 304; viridula 305
- Viburnum 540
- Vicia Faba 491, 502
- Vigna 489, 495; luteola 495, 502; sinensis 249
- Vinca 540
- Viola 414; affinis 413, 414; biflora 406; chinensis 413, 414; cucullata 412, 414; fimbriatula 414; glabella californica 413, 414; hirsutula 414; incognita 413, 414; nephrophylla 413, 414; Nuttallii 414; pallida 413, 414; papilionacea 413, 414, 416; pedata 414; pinnata 413, 414; primulifolia 414; sagittata 413, 414; septentrionalis 413, 414; sororia 413, 414; tricolor 413, 414
- Vitis 448, 461, 502, 540, 543; sicyoides 502
- Wedelia 63, 474, 480; caracasana 474, 502; carnosa 457, 502; Jacquinii caracasana 480; Trichostephia 474, 502
- Wissadula periplocifolia 471, 502
- Wisteria 540
- Woronina polycystis 515
- Wynnea 71
- Xanthocapsa 315
- Xenosporaella larvalis 343
- Xiphias gladius 339
- Xylodon 286
- Xylopodium 24
- Zanthoxylum 413; americanum 413, 414
- Zea 540; Mays 246, 476, 479, 502
- Zeugites mexicana 489, 502
- Zexmenia 482; iners 482, 502
- Zoophagus insidians 532, 533
- Zygorhizidium Willei 521